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NOTES ON THE UTILIZATION OF FORESTS.

(*Continued from page 418, Vol. XVI.*)

CHAPTER III.—UTILIZATION OF THE BARK OF TREES AND SHRUBS.

THE principal uses of bark are for tanning and dyeing, and for furnishing fibres and drugs. On a small scale, it is also employed as covering material, as fuel, and for some minor industrial purposes.

SECTION I.—BARK FOR TANNING.

Tannin is the generic name given to a large class of organic bodies, mostly uncrystallizable, which often differ widely in chemical composition and reaction, but have the common property of precipitating gelatine from its solution and forming insoluble compounds with gelatine-yielding tissues. By virtue of this property they convert animal hide, which is easily putrescible, into insoluble impufrescible leather. They all form blackish-blue or blackish-green compounds with ferric salts, and when treated with alkalies, they give solutions which oxidize rapidly, usually becoming successively orange, brown, and black. Associated with catechu-tannic acid a white crystalline body is found, called catechin, which does not precipitate gelatine. The tannins are met with chiefly in parenchymatous tissues, especially in bark and young wood, in the pericarp or other coverings of green fruits, and in the excrescences called galls. Leaves that darken in drying, like those of the tea plant, of *Anogeissus latifolia*, &c., are rich in tannin.

From the tanner's point of view, tannins may be divided into

two principal classes, *viz.*, those which produce a light fawn-coloured deposit (the bloom) on leather and those which do not. To the first of these belong the tannin of myrabolams, to the second the tannin of cutch.

Tannin is a substance so easily soluble in water that bark intended for it has to be taken off with the greatest care. Bark may be removed (1) from a standing tree, or (2) from fresh-felled wood, or (3) from wood that has become more or less dry. In the first two cases it should be possible to strip the bark off the wood without difficulty; hence the barking must be effected when the union between the bark and wood is weakest, that is to say, at the beginning of the season of vegetation, from the moment the buds begin to swell up to the time the leaves attain their full size. During this period, the cambium is exceptionally active, and the tissues on either side of it are soft and gorged with sap, so that the bark *can then be separated from the wood easily*. Moreover, owing to this special activity, the liber also contains at this time its maximum amount of tannin.

The only portion of the bark which contains tannin in useful quantities comprises the living layers; the dead bark is practically of no value at all. Also, owing to the great solubility of tannin, the moment the periderm begins to split and a rhytidome to form, rain and dew both reach the living layers through the cracks and wash out a large proportion of the tannin. Hence the best stems for the tanner's purpose are those of vigorous growth which have still a smooth uniform shining bark. When this period of growth is past, the yield of tannin diminishes considerably. According to Mueller, as quoted by Gayer, the bark of young poles contains twice as much again of tannic acid as the bark of full-grown trees. The best stems are unquestionably young coppice poles, and coppice worked for tanning bark should be exploited on short rotations. The great drawback in the case of bark which contains a considerable proportion of dead rhytidome is that this latter *must* be got rid of, always with immense trouble, before the bark can be used. The rhytidome without appreciably increasing the amount of tannic acid, introduces a large quantity of undesirable colouring matters into the tanning liquor.

The removal of bark from standing stems (technically termed *peeling*) is thus effected. With a sharp broad-bladed hatchet or a curved bill the bark is cut through round the base as far as the wood. A similar cut is made 3 or 4 feet higher up. Then with the tool represented in *Fig.* 62, which is very sharp along the edge *e*, a straight incision is made from the top cut to the bottom.

The bark on each side of the incision may now be lifted up with ease with the extremity of the same tool or with the ordinary *khurpa* of the Indian gardener. After this, the workman has only to gradually strip off the entire cylinder of bark, aiding himself with the tool wherever it adheres too firmly to the wood. In this manner he peels off successive complete rolls of bark until the entire stem and the thicker branches, if any, have been laid bare. This method of barking is evidently unsuited for large trees. Moreover, it is the most troublesome of the three methods, and should, therefore, be employed only when the stems to be peeled cannot, for some reason or other, be felled at once.

Fig. 62.

Bark scalpel.

In the second method, the bark is stripped off immediately the trees have been felled. The tree may of course be of any size. If the stems are small enough to be rolled about, they may be peeled *in the same way as standing poles,* the bark being taken off in complete rolls. In the case of larger stems, the bark must necessarily be pulled off in narrow strips like semi-cylindrical tiles ; the bark being thick, with a hard rhytidome, all the incisions must be made with an axe, and in order to loosen it, it has often to be beaten with the back of the axe.

In the third method of barking, the tree is cut up into billets, and at any timea fter the tree has been felled, the billets are exposed to the action of steam, under which the bark swells up and is *easily detached. It is evident that only comparatively* thin wood can be peeled in this manner. Ordinary steam, owing to the solubility of the tannin, injures the quality of the bark, and hence the best apparatus are those in which superheated steam is used. Portable apparatus, weighing less than 600 lbs., have been constructed, which, with the labour of only four individuals, give an outturn of more than 2,000 lbs. of bark a day. The researches of Grandeau have proved that the steaming does not affect at all the yield of tannic acid.

Under ordinary circumstances the bark itself is exported after being dried, in order to reduce its weight and volume and to prevent fermentation. Air-dried bark is only from one-half to two-thirds the weight of the green bark. The diminution of volume resulting from air-drying varies from 20 to 40 per cent. To dry the bark, the rolls are stood up close together against one another in the form of a pent roof, a line of rolls being placed along the top like ridge tiles ; or they are piled up in a single row, in low stacks, on

trestles raised at least a foot from the ground. In fine weather they become sufficiently dry in two or three days. Heavy rain is fatal to the bark, and hence, unless the steaming process is resorted to, drying in the open is out of the question for most of our Indian species, since their growing season is ushered in with continuous wet stormy weather.

To obviate this very serious drawback, it is matter for consideration whether it would not be best to fix the season for felling without reference to the production of tannin, and to extract the tannin at once, thus exporting the extract instead of the very much more voluminous and heavier bark. The extract could be either dry and solid or a thick liquid. In either form the tannic acid would keep for ever, whereas in the bark it disappears in the course of two years in spite of the utmost precautions, and combined great heat and humidity, such as obtain in the hold of a ship, would cause it to decompose in a much shorter time. This plan would save cost of packing and carriage in a very remarkable degree, so that our forests, in which thousands of tons of bark now go annually to waste, could supply not only local tanners, but tanners in the most distant countries.* To Captain Wood is due the credit of attempting to introduce this practice into India and thereby utilizing the vast resources of our forests in tanning bark. He has experimented with sál and *Terminalia tomentosa*. The bark

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* The practice of preparing a tanning extract by boiling chips of wood of the sweet chestnut is a very old one, and for many years now the system has been very successfully applied to oak wood in Europe. Within the last 30 years an extract of the hemlock (*Abies canadensis*) bark has taken the place of the crude bark in the exports from Canada and the United States. The mode of preparation is an instructive one for us in India, who have to devise some way of turning to profitable account the thousands of tons of bark which go to waste every year. The bark, in pieces ½ to 1 inch thick and several inches long, is soaked for about 15 minutes in water at 200° Fah. It is then fed into a hopper, which conducts it to a 3-roller machine, something like a sugarcane mill, through which it passes, coming out lacerated and compressed. It next falls into a vat of hot water, where it is agitated by a wheel in order that the tannin from the crushed cells may be dissolved in the water. Hence it is raised by a series of buckets, on an endless chain, to another hopper, whence it is fed to another 3-roller mill. Here it receives its final compression, and comes out in flakes or sheets, like coarse paper, and almost free from tannin. The buckets are made of coarse wire, that the water may drip through. To avoid the blackening action of iron, wherever this metal is brought into contact with the solutions, it is thickly coated with zinc. The solution is evaporated to a solid consistency, generally in vacuum pans. About 2 tons of bark yield 500 lbs. of extract, containing 18 to 25 per cent. of a deep-red tannin, giving considerable weight and firmness to leather.

is chopped up in pieces about 4 inches square and boiled in earthen pots, the strained liquor being completely desiccated or reduced to the consistency of treacle. The extract prepared by the Oudh Forest Department has the defect of containing too much dark colouring matter; but this is, no doubt, due in a great measure to portions of the dead bark having been boiled with the lighter-coloured living bark, a practice to which must also be attributed the very poor outturn in tannic acid (only 2½ per cent. of the dry weight of the bark). With a proper system of manufacture, the yield would be at least doubled, and the percentage of tannic acid in the desiccated extract would certainly reach 50, instead of only 33 as at present. The price of chestnut wood extract, containing 30 per cent. of tannic acid, varies in London from £12 to £15 a ton. There is no reason to suppose that a great many of our gregarious trees would yield a worse commercial article than this latter extract, and we thus only require capital and enterprise to enable our tanning materials to compete successfully in all the markets of Western and Central Europe with such materials from other sources of supply. If caste prejudices militate against the expansion of the tanning industry in India and the local conversion into leather of the shiploads of raw hides which leave the country every year, they cannot be a bar to the preparation of tanning extracts.

We have as yet no figures for the proportion of tannic acid contained in the barks of our various species. Even in Europe the figures are few and contradictory for the three or four species used. In France a quantity of acid varying from 5 to 7 per cent. of the dry weight of the bark is considered good. In Germany the best bark is said to yield 16 to 20 per cent. of its dry weight of tannic acid. But the practical tanner does not value bark only by the quantity of tannic acid present in it. Even in one and the same tree the bark is prized more highly by him, the lower it is obtained from the tree, although the bark from the upper portion of the stem is, as a rule, very much richer in tannin than that from the base. The commercial and practical value of a tanning material depends not only on the quantity of tannin present in it, but also on the character of the leather it produces, whether hard or soft, dark or light-coloured, and heavy or light.

The volume of the bark varies from one-third to one-eighth that of the original unbarked wood, according to the age of the portion or the tree from which this latter has been taken. Hence the barking of firewood diminishes very appreciably both its weight

and volume. On the other hand, the peeled wood always commands a relatively higher price, while the value of the detached bark, if there is any regular market for it, will, after deduction of the cost of removal, drying, and separate export, always exceed the net depreciation suffered by the firewood in consequence of loss of weight and volume due to the peeling.

Some of the best known barks used by tanners are those of *Acacia arabica*, *Terminalia tomentosa*, *Cassia auriculata*, *Rhus Cotinus* and *Rhus mysorensis*, *Garuga pinnata*, *Zizyphus xylopyra*, *Buchanania latifolia*, *Bauhinia purpurea* and *Bauhinia variegata*, *Albizzia procera*, alders, *Quercus incana*, and *Phyllanthus Emblica*.

Tannic acid is not the only product from the bark of trees that serves the purpose of curing leather. The well-known softness, peculiar scent, and water-proof quality of Russia leather are due to its being impregnated, after it has been tanned, with the essential oil distilled from the outer white bark of the birch. Amongst our numerous species some are sure to be found capable of yielding a similar oil.

SECTION II.—BARK FOR DYEING.

Irrespective of tannic acid, which with salts of iron gives various shades of green, purple, maroon, grey, and black, almost all our barks yield, by mere decoction, a large proportion of other colouring matters, some of them red and yellow, but most of them giving some shade of brown. Contrary to tannic acid, most of these colouring matters reside in the rhytidome, so that the older a tree is, the larger will be the amount of colouring matter present in its bark. It is principally these colouring matters which cause a difference in the colour of leather, according to the species of bark used. Up to the present, scientific dyers have not taken up a study of our various tree-barks, and hence their capabilities as dyeing materials for use on a large scale are still only a matter for the future to reveal. All the dyes are permanent. That these dyes are likely to be greatly fancied the moment they become known seems certain from a casual use of the brown dye obtained in bleaching the fibre of *Bauhinia Vahlii*. Mr. Wilson, the gentleman who experimented with the fibre in England, employed the colour in dyeing silk, and produced some elegant shades by different reactions. The bark of *Acacia arabica*, *Hardwickia binata*, *Soymida febrifuga*, *Terminalia tomentosa*, and sál are well known to yield extremely rich browns.

SECTION III.—FIBRES.

All weedy species yield fibre, but it is only a very few, of which

the fibres are strong enough to be twisted without breaking, and the number is still smaller of those the ultimate fibres of which, remaining after the cleaning and bleaching processes, are long enough to be spun. All fibres suitable for cordage and spinning are also excellent for paper-making, for which a great many others also are well adapted. The fibre of the living bark alone is fit for use. The woody species whose bark yields utilizable fibres belong almost exclusively to the Malvaceæ (*Hibiscus, Thespesia, Kydia, Adansonia*), the Tiliaceæ (*Grewia*), the Sterculiaceæ (*Sterculia, Helicteres, Eriolæna*), the Urticaceæ (*Bœhmeria, Pouzolzia, Sarcochlamys, Maoutia, Debregeasia, Broussonetia, Antiaris, Ficus, Ulmus, Sponia*), the Leguminoseæ (*Sesbania, Desmodium, Bauhinia, Hardwickia*), and the Asclepiadeæ (*Calotropis, Marsdenia, Pergularia*). *Careya arborea* and *Daphne papyracea* are two well-known exceptions to this rule. Amongst the Monocotyledons several palms yield fibre.

In all the dicotyledonous species the bark has only to be stripped off in as long ribbons as can be taken off, a certain amount of pounding or beating being necessary to loosen it. In the case of *Bauhinia Vahlii*, however, owing to the peculiar structure of the stem, the stem has first to be first split up into long thin strips, and then pounded until the bark separates from the numerous enclosed wood strands.

Among the woody Monocotyledons, the chief of our fibre-yielding species are the cocoanut palm, from which we obtain *coir* (the fibre surrounding the nut) and the fibre of the leaves and sheathing leaf-stalks, and the *Caryota urens*, the leaves and sheathing leaf-stalks of which give the strong *Kittul* fibre, which is made into ropes, brushes, brooms, baskets, &c. The cord-like fibre obtained from the interior of the stem of the cocoanut, palmyra, Caryota, and other palms, may also serve important uses.

SECTION IV.—OTHER USES OF BARK.

Many barks are used for medicinal purposes, owing chiefly to the alkaloids they contain. The most universally used of such barks is that of the various Cinchonas, which, although exotics, are now cultivated on an extensive scale in plantations treated mostly on the coppice system on very short rotations. Some barks are used for special industrial purposes, those containing gelatinous secretions or tannic acid serving, in many cases, for clarifying sugar. The gelatinous matters coagulate with heat, thus separating from the liquid and carrying away with them the minutest impurities, while the tannin, by coagulating the albumi-

nous matters present, has the same effect. The bark of the *Acacia leucophlœa* is used in the distillation of spirits, the tannin causing the albuminous matters to be precipitated.

Exceptionally, mere temporary huts are sometimes covered with bark, and cheap umbrellas in Upper India are made with the bark of the Bhojpattra. Moreover, the thick corky bark of *Pinus longifolia* is made into charcoal, which is more highly prized than wood charcoal by blacksmiths in the Western Himalayas.

CHAPTER IV.—UTILIZATION OF THE LEAVES OF TREES AND SHRUBS.

The leaves of trees and shrubs are used principally for fodder, manure, litter, and thatching. On a smaller scale they yield drugs (nim, *Vitex Negundo*, senna, *Adhatoda Vasica*, &c.), material for dyeing (Indigoferas, *Lawsonia alba*, &c.), and tanning (*Anogeissus*, *Rhus*, *&c.*), and for matting, basket-making, and paper manufacture (various palms). The number of species which serve these last mentioned purposes is, however, so small, and the quantity of leaves that is actually used, or is ever likely to be required, is so insignificant, that arrangements for meeting the demand for them, without injuring the stock or the resources of the forests, will never present any difficulty.

SECTION I.—LEAVES FOR FODDER.

For fodder, leaves must of course be plucked or lopped green, as otherwise they would have no nutritive value. Moreover, the leaves of most fodder-yielding species are relished by cattle only while they are young and tender, as they afterwards either become too tough and fibrous or acquire an unpleasant flavour. It is scarcely necessary to say that only broad-leaved species yield fodder.

The nutritive value of tree-fodder, as compared with that of the best meadow grass, is as 100 to 125. Lopped twigs and small branches contain from 40 to 60 per cent. by weight of leaves and edible stem-portions.

The practice of lopping is always harmful. Besides robbing the plants of assimilating organs and causing disfigurement and introducing the germs of unsoundness, it deprives the soil of manure more valuable than that furnished by the grass growing under them. This higher value is due to the leaves being less fibrous and decomposing more readily, and also to the fact that the total mass of leaves produced by canopied trees is larger than the entire

quantity of grass growing below. Moreover, leaves are extremely rich in nitrogen and contain up to 8 per cent. of ash, a very large proportion of which consists of potash and phosphates. When wood alone is utilised, nearly all these constituents, which have been collected and brought to the surface by the roots from an immense thickness of soil, are left on the surface to enrich it, and the same matter is thus repeatedly used, year after year, by successive generations of trees. If we remember this fact, and also that it is the dead fallen leaves alone which can, by their decomposition, draw fresh supplies of nitrogenous substances from the atmosphere, and convert refractory compounds of potassium, calcium, and magnesium present in the soil into soluble and assimilable constituents of plant-food, it is evident that the continued removal of the leaf-production of an area injures it not only in the present, but even more so also for the future, and that the injury is greater in proportion to the natural infertility of the soil. Sooner or later, the evil consequences of removing leaves become apparent in the languishing growth of the forest. In a sandy soil, the most careful conservation in other respects will fail to make the trees attain their normal size or grow close enough together to form a leaf-canopy. In very rich soils, the trees may still attain their usual size and form a dense growth, but at a comparatively early age they will begin to decay at the centre, so that they will be unable to furnish timber of any size.

The evil effects of lopping are thus extremely grave and incontestable, and yet we have to permit its continuance in many of our forests in consequence of admitted prescriptive rights. In the higher ranges of the Himalayas, the maintenance of these rights is doubtless unavoidable on account of the severity of the climate during the winter and early spring, when the leaves of trees are almost the only kind of fodder available. But in all other places the right of lopping for fodder is totally unjustifiable, as it only gives encouragement to improvidence. It is true that the leaves of trees are actually lopped only when the grass on the ground is dry and wanting in nourishment, but there is nothing to prevent the same grass being cut in time and converted into hay in anticipation of the coming dry season when the standing dry grass will not be fit to be eaten.

No effort should therefore be spared to suppress, whenever possible, the practice of lopping. Where we are powerless to stop it entirely, it should at least be restricted within the narrowest possible limits, and be regulated on lines having for their objective the safety of the trees lopped. In forest regions rich in species,

there will nearly always be many kinds which are more or less useless from the point of view of timber and firewood, but which yield good fodder. Every endeavour should be made to confine the lopping to such species, and even then the lopping should be effected in such a way as to maintain, to the fullest extent possible under the circumstances, the productive power of the trees lopped. A tuft of foliage at least 5 to 10 feet deep, according to the height of the trees, should be left, and the branches below this level should be cut, with sharp tools, with a clean section, in order to prevent unsoundness and to enable the buds at the base to throw out new vigorous shoots. If the quantity of leaf fodder to be furnished is large, a regular rotation of from 2 to 5 years should be established, the forest being divided into as many blocks, of which only one at a time is to be kept open for lopping. Advantage should be taken of the trees and poles to be removed in the ordinary course of fellings, by allowing them to be lopped for several years preceding their exploitation, thus furnishing at once a not inconsiderable portion of the total amount of fodder required. In coppiced forests, the entire stock of a coupe may be lopped just before it is felled.

When the amount of lopping admissible is very heavy, and it is found difficult or impossible to regulate and control it without serious injury to the forest, the best plan is to set aside a portion of the area exclusively for fodder purposes, and in this area to pollard the trees, either every year or after the lapse of a recurring number of years, according to the system of pollarding adopted.

The leaves of trees and shrubs, like grass and the leaves of pulse crops, may also be dried and stored up for future use. The leaves of various species of *Zizyphus* are used in this way. As a rule, dried leaves make very poor fodder for cattle, but sheep eat them with avidity and thrive on them.

SECTION II.—LEAVES FOR MANURE.

The practice of using vegetable ashes as manure for field crops is one that dates from pre-historic times. The original inhabitants of India probably grew nearly all their crops in forest clearings in the ashes of the felled trees and other vegetation. In spite of injunctions in the Vedas to save forests from fire, the Aryans adopted the customs of the aborigines, in the hilly regions where forest vegetation grew in luxuriance. Even in the plains, where cultivation made rapid progress, the idea that leaves and branches supply valuable ash was not forgotten, and the jungle was cut and spread over the fields, where it was burnt. In this manner, pre-

scription has established rights which the present Government has in most cases, with certain restrictions, admitted. The exercise of such rights being more universal even than lopping for fodder, and one that is, in the opinion of the people and a powerful section of the official class, identified with successful agriculture, is so much the more difficult to suppress, although it is utterly indefensible and is always followed by the gravest consequences.

The only system of using tree-loppings for manure, of which any serious defence has ever been attempted, is that called *rab* in the Konkan districts of Bombay and *beta* on the Malabar coast and in Mysore. It prevails especially in districts where the wet cultivation of rice is practised and the seedlings are transplanted from a nursery, and consists in preparing the seed-beds by burning layers of cowdung or brushwood with subordinate layers of leaves, grass, rice straw, and earth, in other words, in using a kind of surkhí ash for manuring the seed-beds. For this system it is contended that it is the only one which gives good and certain results in the peculiar circumstances in which those districts are placed. These circumstances are (1) the absence of heavy showers before June, when it is necessary to raise the seedlings if they are to be really strong at the time of transplanting; (2) the very heavy early rainfall; (3) the heavy continuousness of the early rains; (4) the early closure of the rains; (5) the absence of rain from the North-East Monsoon; and (6) the absence of facilities for water-storage. Owing, it is said, to these peculiar conditions, seed cannot be sown until the rains have set in, and the seedlings have to be forced, so as to enable the crop to mature within the short period during which the rain continues. Professor Wallace of Edinburgh has lent his powerful name in support of this system, but by merely re-echoing the opinions he heard in Bombay. There is really no reason why the rice cannot be forced by other means. A very simple expedient, which would help very much to shorten the time the crop would require to be on the ground, would be to force germination before the seed was sown.

In Southern India sugarcane fields are also often rabbed on account of the large quantity of manure required by this class of crop. A system of rab was once largely practised in parts of Central Europe and supported by arguments just as specious as those now employed in India; but these arguments could not stand before the march of science, and what was once considered a necessity has now received unqualified condemnation on every side.

Even if we assume, for the sake of argument, that the burning of leaves on the surface of seed-beds is necessary, it is impossible

to understand why dead fallen leaves should not fully serve the purpose. Whether we burn the leaves taken off green or collected only after they have been shed naturally, the ash constituents left behind, after the burning, are practically the same. But, on the other hand, for the forest itself, the removal of green leaves means arrested vegetation and the irretrievable loss of all proteid matters and starch, besides whatever other useful constituents dead leaves contain. There is hence no reason why lopping for rab should not be stopped, even if vigorous rice seedlings cannot be produced without burning leaves on the surface of the beds, for dry leaves could take the place of the green material. The only excuse for rab thus seems to be that the green leaves, being attached to the branches, are more conveniently collected and carried than dead fallen leaves.

In the outer Himalayas, loppings of broad-leaved trees are spread over ginger and turmeric fields as a mulching and to keep the soil loose and warm. At the same time they enrich the soil by their decomposition. But there is no reason why a mulching of straw would not be as effective, while the manurial properties of the leaves could be made good by applying an additional quantity of other manures.

The day must come when, with the march of progress and wealth, this very primitive practice of using the leaves of forest trees for manuring fields will be discontinued, just as the barbarous system of clearing and burning the forest for cultivation has already given place to settled agriculture. Until then, however, we must resign ourselves to arrange for its continuance with the least possible injury to our forests. In the first place, whenever we can do so, we ought to substitute dead fallen leaves for green lopped branches. In the next place, the practice should be rigidly excluded from all areas intended for the production of timber. In fuel forests, the adoption of the coppice system on short rotations should be taken advantage of to furnish a large supply of small branches and leaves at each exploitation; and to save people from coming long distances, there should be numerous small working-circles. The establishment of such small circles of course means excessively detailed work and a large staff, and therefore heavy expenditure. But Government must be prepared to face these drawbacks, if it rules the continuance of the cause thereof. In mere grazing reserves, the same rule must be adopted as for fodder-lopping, namely, restriction of the lopping to definite species and maintenance of a crown at least 5 to 10 feet deep. Where there is a mass of low shrubby vegetation, such vegetation may be cut back once every two or three years,

a short rest being given to enable the soil as well as the root-stocks to recover.

The regulation of the removal of dead fallen leaves and the influence of the practice on the forest are described in the next Section.

SECTION III.—LEAVES FOR LITTER.

The leaves of broad-leaved species, when they die and fall off, become so brittle and rot away so quickly, that the only dry leaves that can be used for litter are the fallen needles of conifers. When the leaves of broad-leaved species are cut green and then dried and spread under cattle, the object is more that of providing fodder and of using the leaves directly as a manure than of obtaining an absorbent medium for the easy and convenient collection of the droppings and urine of the animals. Thus nothing more need be said here regarding the use of the green leaves of trees and shrubs than what has already been given in the immediately preceding Section, and consideration must hence be limited exclusively to the utilization of conifer needles.

The needles of the *pine* tribe, as they contain the largest proportion of fibre, are the best adapted for litter. On the other hand, the needles of the other species of conifers which grow on an extensive scale, namely, the firs and deodar, and in certain parts of the Himalayas, also the larch, yield almost as much ash as the leaves of most broad-leaved species, and have, therefore, a high intrinsic manurial value.

The sweeping away of the entire annual fall of leaves is obviously fatal to the productiveness and maintenance of the forest. But since conifer needles decompose very slowly, and, unless crushed by artificial means, form a thick covering over the ground which prevents all reproduction by seed, the raking away of a portion of the annual fall is more beneficial than hurtful. The operation in question not only diminishes the thickness of this obnoxious covering, but also helps to crush whatever portion of it is left unremoved.

The injurious effects following the removal of the layer of dead leaves covering the soil are greatest (1) on sloping ground, especially exposed hill-sides, since the soil there requires all the protection that can be given it to prevent erosion and impoverishment by the rapid downward filtration of water; (2) on bad soils, in a forcing climate, with naturally quick-growing species, and in youth and in old age, for in all these cases the presence of a large quantity of plant-food in the soil is an absolute necessity; (3) in open forest,

where of course every bit of the exiguous annual leaf-fall must be preserved; (4) in coppice, in which class of forest the soil is more or less completely exposed during half the rotation, so that the protection of the fallen leaves is an absolute necessity during that half, and their preservation and conversion into humus under the leaf-canopy during the other half is the only means of maintaining the productiveness of the soil; and (5) during the season of vegetation, when the soil must be in the most favourable condition possible.

In regulating the removal of dead leaves, two precautions must never be omitted: (1) a rotation must be established, and (2) measures must be taken to ensure a part of the annual fall being left on the ground. The length of the rotation will depend, principally, upon the nature of the soil and locality and the largeness of the demand, and, secondarily, upon the component species, the age of the crop, and the method of treating the forest. The more unfavourable the soil and locality and the heavier the demand, the longer must be the rotation. So also a young or an old crop, an exacting species, and a system of treatment which exposes the soil for long intervals, will require a long rotation. The saving of some portion of the annual leaf-fall is ensured by allowing the dead leaves to be collected only *while* they are falling and *only during the first half of this period.* A combination of the two precautions in question will never fail to result in a considerable quantity of leaves being left on the ground to decompose and form humus and enrich and improve the mineral soil below.

SECTION IV.—LEAVES FOR THATCHING.

Where palms grow in abundance, the leaves often form the entire thatching put into a roof. Before using the leaves, they should be placed over one another, on a dry floor, with the leaflets properly spread out, so that they may dry quickly and well flattened out. When dried thus, they are easily arranged over one another in the roof. If the leaflets are long and narrow, like those of the cocoanut palm, they may be plaited together into a sort of matting. Palm thatching seldom requires renewal oftener than once in three or four years, and then too it is only the upper layers that need replacement. Thatching composed of leaves of the *Wallichia densiflora* is extremely durable.

The leaves of other species, and also often of palms, are laid under or between grass thatch. By increasing the tightness of the roof, they enable it to be made extremely thin and light. Before the leaves can be used, they must be dried, after being pressed to-

gether and tied up in bundles. The leaves of teak and of *Bauhinia Vahlii*, especially the former, are extensively so used and constitute an article of considerable export. Any broad fibrous leaf serves for thatching, and accordingly the leaves of many other species, such as *Butea frondosa*, *Semecarpus Anacardium*, *Diospyros Melanoxylon*, &c., are often used in the vicinity of forests. Matting of palm leaves is often placed directly over the timbers of a roof before the grass thatch is put on and lasts for more than ten years.

SECTION V.—LEAVES FOR TANNING.

The leaves of a few species, such as *Anogeissus latifolia*, *Rhus Cotinus*, &c., are used in tanning. The leaves should be collected only when they are mature, but while they are still full of sap and before their colour changes previous to their being shed. The change of colour results from the appearance of colouring matters, which have their effect on the leather. Hence for white or light-coloured leathers there ought to be no delay in picking. The highest quality of leaves is obtained nearest the ends of the branches. After being picked, the leaves should be first wilted, then spread out and quickly dried, either in the sun or on racks arranged one above another in a heated room. To accelerate the process, the leaves should be frequently turned. Leaves properly dried should be greenish. For convenience of export, the leaves should be ground into a coarse meal.

The dried leaves of the various species of Rhus used for tanning contain 16 to 24 per cent. of gallo-tannic acid, and make a soft, pale-coloured leather. The leaves of Anogeissus give a similar leather, and the samples analysed by Professor Hümmel yielded 15½ per cent. of tannin, while those of the leaves of *Phyllanthus Emblica* gave as much as 18 per cent. The decoction of the leaves of both these species obtained by the Professor was of a pale yellow colour and slightly turbid.

SECTION VI.—SOME OTHER USES OF LEAVES.

The leaves of *Melaleuca Leucadendron* yield the Cajuput oil of commerce. The leaves of *Terminalia Catappa*, *Baccaurea sapida*, and some other species are used in dyeing, those of the first giving a black dye. The leaves of *Butea frondosa*, *Bauhinia Vahlii*, and *Cordia Myxa* are very largely used by Hindus in the place of plates and cups. The plates are formed of several leaves pinned together with long spines or stiff grass stalks, while the cups consist of one or several leaves bent and pinned to the proper shape. The same

leaves are also used by shopkeepers to wrap round grocery and other small articles that they sell. For these various purposes the leaves in question are exported to great distances. The leaves of the plantain are also used for plates. Both the leaves of the plantain and of species of Bauhinia take the place of paper in the cigarettes smoked by the people of the Western Coast, while the leaves of Cordia are used to cover Burmese cheroots. The dried leaves of nim, *Vitex Negundo*, and some others are used as insectifuges. Pine needles, digested in a solution of caustic soda, yield more than 80 per cent. of their dry weight of a fine fibre (*pine wool*), which is made into felt and is woven into cloth resembling woollen fabrics.

CHAPTER V.—UTILIZATION OF MINOR PRODUCE OBTAINED FROM FELLED WOOD.

The stem, besides yielding major produce, *viz.*, timber, firewood and wood for charcoal, furnishes many other useful products that are extensively used. They may be grouped under the heads of (1) dyes and other extracts, (2) oils and the various products of distillation, and (3) starch.

SECTION I.—DYES AND OTHER EXTRACTS.

The heart-wood of every species owes its colour to a substance or substances which can be used in dyeing; but these substances must be capable of being extracted with ease and in sufficient abundance to have a commercial value. In spite of the very slight knowledge possessed by our dyers of the various modes of manipulating dyeing substances, a great many dye woods are already used by them as well as by the general population. The Jack wood, *Plecospermum spinosum*, and various others yield a yellow dye. *Pterocarpus santalinus* gives a very pretty salmon-pink dye, *Cæsalpinia Sappan* and *Adenanthera pavonina* a red dye, *Cynometra ramiflora* a purple dye, and so on. But the most common colour yielded is some shade of brown. The easiest way to obtain the dye from wood that has been sawn is simply to boil the saw-dust. But for work on a commercial scale, the wood, before being boiled, would be most quickly reduced to thin shavings on a lathe.

The two best known and most widely used wood-extracts are the cutch and katha of commerce, the former being used principally as a dye and exported to Europe, the latter being chewed with betel and the betel leaf. From Upper Burma alone the annual exports, a few years before the annexation, amounted to 150,000

maunds, valued at Rs. 11,00,000. Since then, owing to restricted cuttings in consequence of reckless utilization during the late dynasty, they have diminished 50 per cent. in quantity and about 40 per cent. in value. In Lower Burma, in two Divisions alone (*viz.*, Tharawaddy and Prome), the annual revenue from cutch is not less than half a lakh of rupees. In India proper, the manufacture is on a much smaller scale; nevertheless the quantity carried by rail and river in 1888-89 was over 33,000 maunds, valued at Rs. 5,00,000.* Many of our dark-hearted trees, such as *Hardwickia binata*, *Soymida febrifuga*, &c., would, no doubt, yield dyeing extracts quite as valuable as cutch. Industry and enterprise alone are wanting to bring them into use.

Section II.—Oils and other products of distillation.

The oils at present distilled from wood are those obtained from sandal-wood, from teak, from deodar, and from pines (chiefly *P. longifolia*, *Khasya*, and *Merkusii*).

Amongst these, the only articles of commerce are the produce of the sandal-wood, *Pinus longifolia*, and teak, the rest either having a very local use or being manufactured to meet an occasional demand.

The process of manufacture of sandal-wood oil will be described in Part III. A large quantity of wood is now wasted which would profitably be used for distilling the oil, and the establishment of stills in all the sandal-wood forests of Madras, Mysore, and Coorg would permit of those forests being worked and treated on a much more intensive system than can be adopted under present circumstances.

The oil of the deodar and *Pinus longifolia*, as well as of teak, is obtained by destructive distillation. The method of distillation is extremely primitive. Chips of the wood, long enough not to fall out, are put into an earthen pot with a narrow mouth. The chips are set on fire, and the pot is inverted into another, with a broad mouth. As the wood burns, the vapour of the oil condenses against the sides of the upper pot and the oil trickles down into the lower one. Sometimes the wood is not set on fire, but the two pots are so arranged that the inverted one is surrounded with fire. In either case, the produce obtained is never quite pure, as tarry matters and acids distil with the oil and discolour and taint it. This is, however, actually no disadvantage in the case of the conifer oils, which are at present used only for friction in rheumatism and skin diseases. Teak wood oil is rubbed into inferior woods to make them more durable and to give them the odour and oiliness of teak wood. In each one of these cases, tarry matters and a small quantity of acid probably add to the effectiveness of the oil.

* For further particulars regarding cutch and katha, *see* Part III.

Teak wood oil, being siccative, is also sometimes used in the place of linseed oil.

The other products of distillation of wood, in which there is a trade, are acetic acid, wood-spirit, creosote, and tar. Of these, tar alone is made in this country, and that, too, only on a very small scale for local consumption. The method of preparing wood-tar directly has already been described on page 147, and will again be further noticed in Chapter IV. of Part III. Although wood-tar can never compete with coal-tar in the general market, there is still plenty of room for its more extended use in and near the areas where deodar and pines grow.

The method of dry-distilling wood will be explained under the head of charcoal-burning in Part III. The acetic acid obtained directly from the distillation is full of various other products, and is in that condition termed pyroligneous acid. The pure acid is separated in the form of an acetate of lime, which is then heated with sulphuric acid, or, better still, hydrochloric acid, the base going to form sulphate or chloride, as the case may be, and setting free the acetic acid. Acetic acid is a powerful solvent of various organic bodies, camphor, resins, essential oils, phosphorus, &c. It is extensively used in the treatment of gums, caoutchouc, and various albuminous substances, in the manufacture of paints and varnishes, and as a drug. The uses of vinegar are well-known. The crude pyroligneous acid, owing to its containing creosote and other hydro-carbons, is a powerful antiseptic. Finally, acetic acid forms a series of salts, or "acetates," of special value in calico printing, dyeing, and other branches of industry.

Wood alcohol is, however, the most important product of the dry distillation of wood and constitutes about 1 per cent. of the distillate. Combined with sugar alcohol in the proportion of 10 parts to 90 of the latter, it becomes the methylated spirits of commerce, a product of such wide use in the arts and manufactures and in the scientific laboratory. Bleaching powder acting upon wood spirits produces chloroform. Ether is prepared by heating alcohol with sulphuric acid.

The products of the dry distillation of wood comprise, besides the substances already mentioned, all the substances, such as paraffin, benzene, &c., yielded in much larger quantities and at infinitely less expense by the distillation of coal.

SECTION III.—STARCH.

The only woody Indian species from which starch is extracted are a few palms, such as *Caryota urens*, *Phœnix acaulis*, Arenga, and Corypha. This starch is, however, only consumed locally

and has practically no market value. But there is no reason why it should not become an article of trade. Owing to the peculiar structure of the stems of palms, the centre consists entirely of cellular tissue rich in starch, the quantity of which is generally largest towards the base, where the reserve materials are principally stored up. The starch is easily separated from the tissues containing it. These tissues are crushed and well rubbed and washed in water. The whole is then thrown upon a fine sieve, through which the starch passes with the water. The water is evaporated and only the starch remains.

CHAPTER VI.—UTILIZATION OF MINOR PRODUCE FROM WOODY ROOTS.

The roots of woody plants yield (*a*) food for man (*e.g.*, yams, *Pueraria tuberosa*, &c.; (*b*) drugs (*e.g.*, *Strychnos Nux-vomica*, *Hemidesmus indicus*, *Cissampelos Pareira*, mudar, some barberries, &c.); (*c*) fibres (*e.g.*, *Butea frondosa*, the aërial roots of some figs, &c.); (*d*) dyes (*e.g.*, chay or *Hedyotis umbellata*, known as Indian madder; *Rubia cordifolia*, yielding *manjit*, a product much resembling madder; *Morinda citrifolia*, yielding a scarlet dye, species of *Berberis*, a yellow dye, *Ventilago Maderaspatana* orange by itself, chocolate with chay, and black with galls; and so on). Many edible wild roots contain some acrid principle which can be got rid of only by long boiling. The fibres of the roots of the *Butea frondosa* are easily separated by beating the whole root with the back of an axe. These fibres, however, make only very coarse cordage which becomes brittle in drying. Strips of the fresh-cut root are used for tieing up thatch.

CHAPTER VII.—EXUDED PRODUCTS.

These are very numerous and of extreme importance. They may, for our purpose, be divided into (1) sugary sap, (2) gums, resins, and varnishes, and (3) rubbers.

SECTION I.—SUGARY SAP.

The utilization of such sap is the basis of a very extensive industry. In India, the palms are the only family which contain trees that yield sugary sap. Those usually tapped are the cocoanut and palmyra palms, the *Caryota urens*, the *Arenga sacchari-fera*, the *Nipa fruticans* and the wild date palm. The first four yield juice from the cut stalk of the inflorescence before the flowers appear, the last from incisions made in the stem at the base of the lower leaves, which are cut off. The sap, or toddy as it is called, of these palms, flows in abundance. While it flows it is collected twice a day, the daily yield varying from a pint or two to several gallons. Nearly every spathe may be tapped, and the yield, there-

fore, depends on the number of spathes developed or cuts made. The same spathe or cut goes on giving toddy for nearly half the year; but periodically, about once, twice, or thrice a week, a thin piece has to be sliced off to freshen the wound. In the case of the wild date palm, the sides of the incision are freshened once a day for three days running each week, and the quantity of juice collected in the morning after each re-cutting is, in Bengal, respectively 16, 6½, and 3 pints. During the three remaining days the outflow is insignificant and the trees are allowed to rest before being cut again.

The toddy is largely drunk; but the greater portion is fermented and made into spirits and vinegar, or boiled down into raw sugar, which is refined at Cossipore in Bengal and in many places in the Madras Presidency. Toddy is nearly as rich in saccharine matters as cane juice, and as, unlike this latter, it is entirely free from colouring matters, chlorophyll and other impurities, the sugar it yields is much easier to clarify. The proportion of gur obtained from date juice averages one-tenth by weight. The palm gur, as actually made, contains a large proportion of gluten, which causes it to deteriorate sooner than cane gur.

SECTION II.—GUMS, RESINS, AND VARNISHES.

Gums are degradation products of the secondary cell-wall. The essential constituents of gums are *arabin*, *cerasin*, and *bassorin*, and according to which one of these three is present or preponderates, we have gum, arabic, cherry gum and gum tragacanth. Other constituents of gums are dextrin, sugar, tannin, colouring matters, and mineral ingredients. The various kinds of gum arabic, the type of which is obtained from several species of Acacia, are readily soluble in water at all temperatures and have the same composition as starch. They are the only gums which can be used for adhesive purposes. Cherry gum, to which category belong the exudations of *Bauhinia Vahlii* and *Thespesia populnea*, is insoluble in water, but absorbs it greedily and swells up into a transparent jelly-like mass. Boiled with a small quantity of some alkali, it is converted into gum arabic. Gum tragacanth, which is typically represented by the gum (*katira*) of the Sterculias, of *Cochlospermum Gossypium*, of *Eriodendron anfractuosum*, and of the cocoanut palm, is also insoluble in water, but, above a certain low minimum temperature, it absorbs water energetically, increasing enormously in bulk. It, however, becomes soluble when treated with an alkali. When acted upon by weak sulphuric acid, it yields a sugar that is incapable of fermentation. Most of our gums are mixed gums, that is to say, they contain two or all three of the three main constituents. Gums have various uses besides their

employment as adhesive material. They are used in pharmacy as a medium for medicaments and as mucilage for soothing internal inflammation; also directly as a medicament itself. They are also largely employed in calico printing, in sizing paper, and in confectionery.

Resins are also degradation products of the cell membrane, but sometimes they are derived from fine-grained starch. In most species, the change into resin is brought about in those cells the vitality of which has been diminished from any cause. It is for this reason that resin is found in greatest abundance in the region of wounds, and that the stumps of felled pine and deodar trees become almost transparent with the large proportion of resin formed by the degradation of the cell-walls. Resins are soluble in alcohol, ether, and carbon disulphide, but insoluble in water. They burn with a bright or a smoky flame.

Resins may be classified into (1) true resins, (2) gum-resins, and (3) oleo-resins. The true resins are (*a*) hard or copaline, as the resins of *Vateria indica* (piney), *Hopea odorata*, *Dipterocarpus tuberculatus*, *Shorea* spp., and *Canarium bengalense*, or (*b*) soft or *elemi*, as the exudation of *Boswellia thurifera*. The gum-resins embrace three sub-classes, (*a*) the emulsive (*e.g.*, gamboge of *Garcinia Morella* and kino of *Pterocarpus Marsupium* and *Butea frondosa*), (*b*) the fetid (*e.g.*, asafœtida and the exudations of *Gardenia lucida* and *gummifera*), and (*c*) the fragrant, this last being further sub-divided into two sections, represented respectively by the exudations of Balsamodendron (bdellium) and mango, and that of the genus *Styrax* (gum benjamin or benzoin). The oleo-resins embrace balsams (*e.g.*, the gurjun "oil" of *Dipterocarpus turbinatus*, the wood "oil" of *D. lævis* and *D. zeylanicus*, and the copaiba-like balsam of *Hardwickia pinnata*), natural varnishes (*e.g.*, the lacquers of *Melanorrhœa usitata*, *Rhus vernicifera*, *Semecarpus Anacardium* and *travancorica*, *Holigarna longifolia*), and turpentines and tars (the products of numerous conifers).

Gums are found in exploitable quantity only in the bark, while resins are formed in the wood as well as in the bark. In the bark the resin always occurs in special receptacles (resin cells or ducts); in the wood there may be special reservoirs, as in pines, or the resin may be secreted in the vessels themselves, as in the wood of the Dipterocarpeæ.

According to where the resin or gum is secreted, and to whether the secretion has or has not to be artificially aided, we have three modes of collection, *viz.*, (1) collection of spontaneous exudations, (2) collection from wounds made in the bark, and (3) collection by tapping the wood.

ARTICLE I.—COLLECTION OF SPONTANEOUS EXUDATIONS.

During the season of rest, especially when the bark becomes dry and cracks, and the tree, unable to transpire, is full of moisture, the low vitality of the numerous cells in the bark results in the formation of gum. It is also at this time that the outflow of resin is most active. The quantity of resin that bursts through the bark and exudes spontaneously is too insignificant to become an object of regular exploitation, and hence only gums are thus collected. Gums obtained in this manner comprise those furnished by *Anogeissus latifolia* and some of the Acacias, especially *A. arabica*. The yield of gum is largest after a forest fire, which not only reduces the vitality of the trees, but also enlarges existing tracks and creates new ones. The prolonged hot dry weather which precedes the setting in of the summer rains, however, suffices to produce a large quantity of the degradation product, chiefly in the more unhealthy trees; and we have thus a means, without setting fire to our forests and injuring growing timber, of deriving some sort of utility from trees, which, although they hold out no promise in respect of wood production, cannot, for some cultural reason or other, be removed.

ARTICLE 2.—COLLECTION FROM WOUNDS MADE IN THE BARK.

This mode of collection is employed chiefly in obtaining the kino of *Pterocarpus Marsupium* and *Butea frondosa*, the gum of *Bauhinia retusa* (semla), and, in poor forests, also of *Anogeissus latifolia*, and the exudations of the Garcinias. In the case of all but the last, vertical rows of parallel, slightly oblique gashes, a few inches long and about 6 inches apart and penetrating as far as the wood, are made in the bark, all round the stem, and also round the main branches of small trees. The exudation collects generally in long or globular tears. It is allowed to harden on the wounds and is then broken or scraped off.

The semla is subjected to a very systematic utilization. The trees are tapped twice in the year, *viz.*, during the dry seasons preceding respectively the summer and winter rains. The gashes are cut in March-April and September-October, and the gum collected in May-June and November-December. A rest of from one to two years after each year of exploitation suffices to enable the wounds to heal over and the trees to recover completely. According to Babu Karuna Nidhan Mukerji, the average yield per tree is about 5 seers of gum, which sells in the Dehra Dún bazar at an average rate of Rs. 3 per maund of 82 lbs. The semla gum, like that of *Anogeissus*, is used in calico printing and is also eaten. The yield of kino from *Butea frondosa* is about the same as the yield of gum from the semla, while that from Pterocarpus trees, which

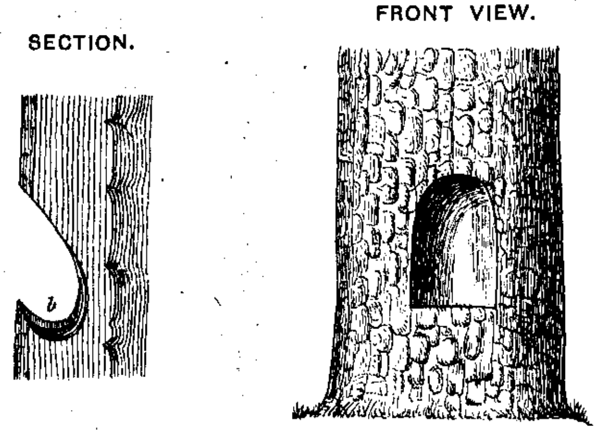
often attain an enormous size, is, no doubt, very much larger. The firs give resin only from the bark, but the yield is so small, that in the present state of the market it does not pay to tap those trees.

The true gamboge is not collected in India, although the tree which produces it, *Garcinia Morella*, grows in the forests of South India. In Ceylon the tree is tapped thus. Thin slices are cut off the bark here and there. On the flat space thus exposed the gum collects and is scraped off when sufficiently dry.

ARTICLE 3.—COLLECTION FROM WOUNDS IN THE WOOD.

This is the only mode of collecting the resins of the Dipterocarpeæ and of pines. The native method of tapping both families of trees is to cut one or more deep niches, according to the size of the tree, into the stem, at about 4 feet from the ground (*Fig.* 63). The height of the niche is about 18 inches and the

Fig. 63.



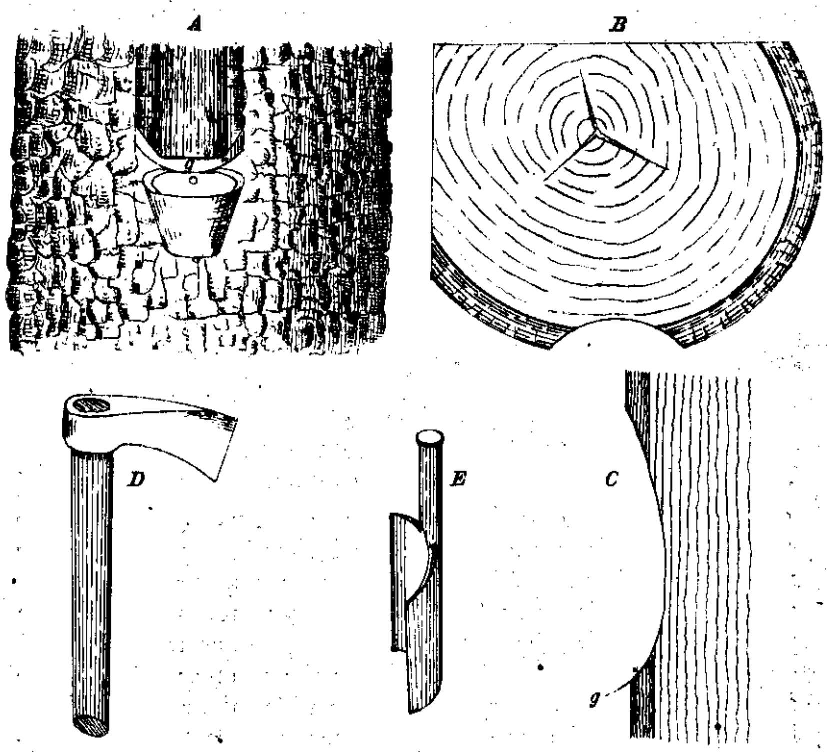
Niching Pinus longifolia *for resin.*

width at the opening about 1 foot. At the bottom it is hollowed out into the form of a deep bowl (*b* in Section) to receive the resin that runs down the sides. This hollow is emptied as fast as it fills up ; in the case of *Pinus longifolia*, once in from 4 to 10 days when the niche is first made, and at longer intervals afterwards when the outflow diminishes. The Dipterocarpeæ are tapped during the dry hot months preceding the summer rains, *Pinus longifolia* during February-June, after which the resin, although it continues to flow, does not do so fast enough to tempt the collector to extend his work into the rains. In the pine a niche is worked for two and three consecutive seasons, unless a forest fire occurs and chars all the inside ; and the yield is from 3 to 6 lbs. the first year, a little more than half that quantity the second year,

and almost as much the third year. From time to time, however, the resin encrusting the sides of the niche must be scraped off and the wound freshened. The method of tapping just described obviously injures the stem, and as the object of the tappers is to obtain the largest quantity of resin, the pines always suffer in their growth if they do not become sickly and die. It has been found that more than one niche in a tree up to 18 inches in diameter kills it. The open niche also allows bark and other impurities to fall into the turpentine.

Since 1887 systematic tapping operations have been carried on in the *Pinus longifolia* and *P. excelsa* forests in Jaonsar. An attempt has been made to follow the system employed in the tapping of the cluster pine in the west of France; but as the French curved-bladed axe (*Abchot*, *Fig.* 64 *D*) was found too

Fig. 64.

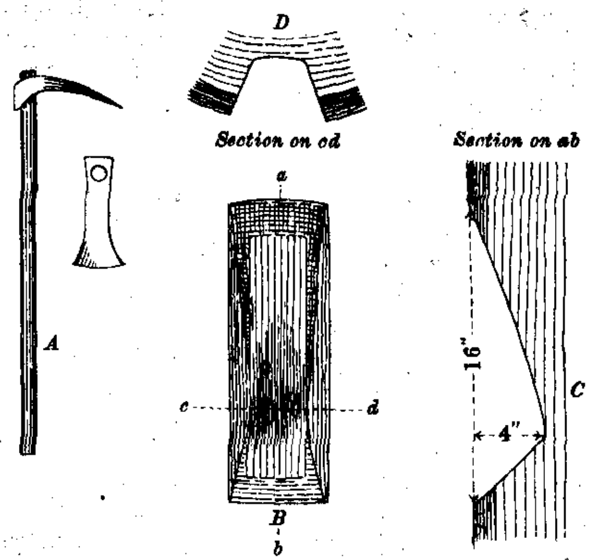


French method of tapping pine for resin.

A.—Blaze in full operation.
B.—Blaze shown in horizontal section.
C.—Blaze shown on a longitudinal section.
D.—Abchot *or curved-bladed axe.*
E.—Curved chisel for making incision for admission of zinc gutter g in A.

heavy by the hill-men, the blaze has been made with the ordinary hill adze (*Fig.* 65 *A*). It would, however, be easy enough to

Fig. 65.



Departmental method of tapping the Pinus longifolia *in the Jaonsar Division, School Circle, N.-W. P. and Oudh.*

A.—Hill adze (weight under 2 lbs.)
B.—Blaze in elevation.
C.—Section on a. b.
D.—Section on c. d.

get lighter abchots made and the men would soon get into the way of using them. Regarding the superiority of the abchot to the adze there can be no question. It is more than twice as expeditious and effective, and for the same size of blaze injures the tree less, while the gently sloping edges of the blaze get more quickly covered over with the new deposits of wood (compare sections in *Figs.* 64 and 65). Then, again, in using the adze there is always risk of the tool working obliquely towards, and exposing, the heartwood, and the sides of the blaze can never, from time to time, be freshened by the removal of a layer of wood, a mere fraction of an inch thick, as can be done with the abchot. *Fig.* 64 *D* represents a blaze in operation, with a zinc or galvanised iron gutter *g* fixed into the stem at the base of the blaze and a pot suspended immediately below, into which the resin drops from the gutter. The blaze, which has a nearly constant width of a little over 5 inches to begin with, should be made about 16 inches long.

In Jaonsar it is given a depth of 4 inches near its lower extremity (see *Fig.* 65 *C*). The depth is excessive, but it is impossible to make a shallower cut with the wretched adze used. The adze or abchot, whichever is employed, should always be almost as sharp as a razor, as a blunt edge, instead of cutting the resin ducts with a clean section, would bruise and lacerate the surrounding walls and thus choke up the entrance to the cavities. To preserve the edge of the tool, the dead, rough bark should be removed with an ordinary axe, and all old dry resin scraped off with a khurpa before using it. In Jaonsar the receiving pots were originally of iron, but they were so frequently stolen, that they are now made of ordinary baked clay, and are practically merely small flower-pots of about one imperial pint capacity.

As the gutter consists of only a thin flexible metal plate (*Figs.* 64 *A* and *C*, *g*) a groove is made to receive it with a curved chisel (*Fig.* 64 *E*). The metal plate is inserted into this groove and driven home with light blows.

Once a week, and even oftener when the resin flows very freely, the blaze must be freshened, as some of the exudation dries on the surface, thus clogging it and arresting the outflow of resin. In freshening the wound, a thin slice of wood, not more than the thickness of ordinary writing paper, should be taken off. At the same time that the blaze is freshened, it should be extended upwards a small fraction of an inch at a time, so that the blazes become generally longer with the advancing season.

Our experiments in Jaonsar have now gone on for three years, and there is still no point of any blaze either in *Pinus longifolia* or in *P. excelsa* from which resin is not still oozing out. In the niche system too, in the case of *P. longifolia*, the aggregate outflow during the second and third years exceeds that of the first year, and is very nearly as large in the third as in the second year. Such being the case, the extension of the blaze upwards should be effected very gradually, and when the length of any blaze becomes so great that the resin from the upper portion becomes too thick to run down freely until it reaches the gutter, a second gutter should be inserted about two feet above the first. The resin from this gutter may be allowed to drop directly on to the lower one, or a second pot may be hung on one side of the blaze and the gutter so shaped as to carry the resin sideways into it. It would not answer to suspend the second pot in a line with the blaze, for then the continued freshening of the blaze would become an impossibility, or would at any rate be extremely incommoded. If experience shows that it is desirable to extend the blazes to a

height of several yards, a series of such gutters and pots will have *to be fixed one above another.*

Experience both in Jaonsar and in the Punjab has proved that, although the flow of resin is most active during the season of rest and when the weather is warm and dry, it still continues to ooze out in fair, and sometimes in considerable, abundance throughout the rest of the year. Pots left hanging in winter, under the snow, have been found to have overflowed with resin. It is, therefore, *for consideration whether somewhat larger pots than those now used* should not be tried, and due arrangements made for carrying on operations during the entire open season. Rainy weather is no drawback at all, for water being lighter than the resin cannot prevent the pots from filling with the latter. Large pots would also necessitate less frequent visits to each tree in order to collect the exudations, and one man could then look after more trees than he does now.

The blaze system of tapping, although it is only in an experimental stage, already promises to produce a larger outturn than the niche method. The two systems, carried out with chir trees situated in one and the same area, gave the following yield in the first year :—

Average per niche, ...	7·4 lbs.
" " blaze, ...	6·2 "

The niched trees were all large and specially selected, 20 in number, while the blazed trees numbered 3,221 and covered a whole hillside of about 200 acres only, so that many of them were quite small and not very vigorous. In the second and third years the niched trees gave respectively 4·9 and 4·5 lbs. per niche, whereas the corresponding figures for the blazed trees were 7 and 8 lbs.* respectively per blaze. Even if the blaze system did not increase the yield, it at least saves the base of the stem from complete mutilation, and as it determines a flow of resin in the trunk uniformly in every direction, it will produce more highly resinous and therefore harder and more durable timber. Mr. Mann says that a single long blaze is often made in the trunk of Khasya pine trees one year before they are felled, with the object of increasing the amount of resin in the wood. The wood of trees so treated contains 16 per cent. of its total weight of resin.

A remarkable fact brought to light by the experiments in Jaonsar deserves to be mentioned. If a blaze goes through the sapwood of the *Pinus longifolia*, the exposed heartwood soon becomes full of cracks and dries up at the surface, and ultimately the flow of resin from the blaze is almost completely arrested. In the *Pinus*

* The two last figures are only approximate, as the exact figures have not yet been communicated to the author.

excelsa, however, the outflow of resin apparently remains unaffected, even if a portion of the heartwood is removed in making the blaze.

Those of our conifers, the tapping of which is likely, in a near future, to become a large and profitable exploitation, comprise the three pines, *Khasya*, *Merkusii*, and *longifolia*, and perhaps also the *excelsa*. The aggregate areas covered by these pines are estimated respectively at roughly 200, 50, 2,000, and 100 square miles ; but in these figures is probably included a large proportion of poorly stocked areas. The resin of the Khasya pine is the best, as it yields a purer oil than any other conifer resin in the world. The oil of *Pinus longifolia* is the least pure and has the least pleasant odour. It has also the great defect of not drying quickly—a characteristic which unfits it for the manufacture of varnishes. Excluding impurities, the turpentine consists of 18 per cent. oil and 82 per cent. colophony. The corresponding figures for *Pinus excelsa* are 22 and 78 respectively.

The utilization of the various turpentines will before long give rise to an important forest industry from the borders of Afghanistan to the frontier of Siam. A short account of the manufacturing processes through which the raw product passes will hence be given in Part III.

SECTION III.—CAOUTCHOUC AND ITS ALLIES.

These substances are found suspended, in the form of small granules, in the latex of numerous plants belonging principally to the *Euphorbiaceæ*, *Apocynaceæ*, *Asclepiadeæ*, *Sapotaceæ*, *Lobeliaceæ*, and *Urticaceæ*. The latex, after a shorter or longer exposure to the air, becomes coloured brown, and the granules separate of themselves from the rest of the liquid and form a solid independent mass. Caoutchouc is insoluble in water, acids, alkalies, and alcohol; soluble, but without any chemical change, in carbon disulphide. Its composition is complex, but its market value depends upon a proportionate abundance of the elastic substance, with a relative absence of a certain oxidized, viscid, resinous body soluble in alcohol, whose formation is in great measure prevented by rapid evaporation of the milk and other means of avoiding oxidation.

In India the only species tapped on a large scale for caoutchouc is the *Ficus elastica*. In Burma *Parameria glandulifera* is said to yield a product equal to the best Para rubber, and *Urceola esculenta* is described as very abundant, but not yielding as good a rubber. Both are Apocynaceous climbers. They are not tapped, but cut down, and the bark is at once stripped off and boiled. The hot water, however, causes much of the milk to coagulate inside the bark and thus reduces the yield very considerably.

The *Ficus elastica* throws out numerous large aërial roots, some of which run for many feet along the ground. Both the stem and these roots are tapped, the latter being more productive. February-March is considered the best time for tapping. Oblique incisions, about 3 inches wide across the middle, are made right through the bark. The exudations, if abundant, are received in conical cups made of folded leaves (pots would surely be more convenient and effective); otherwise they are allowed to concrete on the wound. Native collectors often allow the milk to run down into holes made in the soil. The incisions used to be made only 1 foot apart, but this was found to weaken the trees. In the State forests an interval of 2 feet is now adopted; and in tapping the same trees again, the new incisions are made between the old ones; as if these latter are opened again, not only do the trees suffer in vigour, but the yield of milk is diminished 50 per cent. If the milk is left to itself, it solidifies in about 20 days, when it is stripped off the wounds or taken out of the leaf-cups or holes in the ground, and kneaded into a ball, whence the designation of *ball rubber* for this product. *Leaf* or *slab* rubber is thus prepared. The fresh milk, collected within 24 hours after incision, is poured into boiling water, and the mixture is briskly agitated until the rubber separates and can be handled without sticking and kneaded. A more elaborate plan is to run the milk into wooden bins partially filled with water, on which the rubber begins to float after a time. The rubber, while still liquid, is removed and boiled over a slow fire in iron pans 4 to 6 feet in diameter and 2½ feet deep, two parts of water being added and the whole stirred constantly. When coagulated, the rubber is removed with iron forks, pressed, again boiled and pressed, sun-dried, and washed over with lime.

The average yield of rubber is one-third the weight of the semi-liquid latex. Ball rubber is obviously more impure than loaf rubber (the impurities often reaching 35 per cent). Owing to longer exposure to oxidation, while coagulating naturally, it also gives a smaller yield. Even when loaf rubber is made, a certain quantity of the ball kind is obtained from what collects subsequently and solidifies in the wounds. The ball rubber, when just pulled off the tree, contains about 17 per cent. of moisture, which, however, it soon loses after being rolled up and sunned.

The yield of course varies very much with the size and age of the trees and the number of aërial roots, and with the weather. Unseasonable rain may wash away almost all the latex. Middle-aged trees are the most productive. Large healthy trees have been known to yield as much as 150 to 200 lbs.; but the average yield,

in the present condition of the forests and plantations, is only about 10 lbs. per tree.

The trees require at least one year's rest between two tappings, otherwise they decline in health and may even die. Gamble recommends a rest of two years.

The total exports of India-rubber from and through Assam amounted, in round numbers, to 7,500 lbs. in 1887-88, of which 1,000 lbs. came from Bhutan and other tracts inhabited by hill tribes. The price of the rubber at Calcutta fluctuates considerably, but the average may be taken at Rs. 80 per maund, or very nearly Re. 1 per lb.

Gutta-percha is closely related to caoutchouc. The tree that yields the gutta-percha of commerce, *Dichopsis Gutta* (one of the Sapotaceæ) is not a native of India; but one Indian species, *D. polyantha*, yields a very good article, quite capable of exploitation. Mr. B. F. DaCosta claims to have discovered in the latex of *Euphorbia neriifolia* a substance having the properties of gutta-percha and capable of being substituted for it.

CHAPTER VIII.—UTILIZATION OF ANIMAL PRODUCTS.

The most important of these are lac and lac dye; silk; honey, wax, and manna; and hides, horns, bones, and ivory. Under this head may also be included hunting and fishing.

SECTION I.—LAC AND LAC DYE.

The lac insect (*Coccus Lacca*) frequents a great many species of trees and shrubs, but of these *Schleichera trijuga*, *Butea frondosa*, *Zizyphus Jujuba*, and *Shorea laccifera* are alone gregarious enough to be regularly exploited for lac without resort to artificially-raised plantations.*

* Besides the above, the following trees and shrubs are frequented by the lac insect:—

Acacia arabica and *Catechu*.
Anona squamosa.
Butea frondosa and *superba*.
Carissa Carandas.
Celtis Roxburghii.
Croton lacciferus.
Dalbergia latifolia and *paniculata*.
Dichrostacheys cinerea.
Dolichandrone Rheedii.
Eriolæna Hookeriana.
Erythrina indica.
Feronia Elephantum.
Ficus bengalensis, *cordifolia*, *elastica*, *glomerata*, and *infectoria*.
Garruga pinnata.
Kydia calycina.
Lagerstræmia parviflora.
Mangifera indica.
Nephelium Litchi.
Ougeinia dalbergioides.
Pithecolobium dulce.
Prosopis spicigera.
Pterocarpus Marsupium.
Schima crenata.
Shorea robusta.
Tectona grandis.
Terminalia tomentosa.
Zizyphus xylopyra.

The lac insect breeds twice, and, in Mysore, even three times a year, but the spring brood yields the largest quantity of lac. As the insect can survive and form thick incrustations only on twigs of generous growth, the trees on which it is cultivated should always be pruned and lopped, in order to induce an abundant crop of strong juicy shoots. In the case of *Butea frondosa*, it will doubtless be best to adopt pollarding outright.

To cause the insect to spread over the whole tree or bush, the *brood lac*, as it is called, which is nothing more than fresh-broken lac from which the young insect has not yet swarmed out, is cut up into short pieces 6 to 12 inches long and tied up at various points in the crown, after being surrounded with a few wisps of straw in order to protect the young brood inside from injurious weather influences and to create numerous points of contact with the branch to enable the larvæ to pass over at once. The pieces should be tied up in the upper and middle branches, so that any wandering larvæ that may fall off from them may not be lost on the ground, but find a lodgment on the lower branches immediately underneath.

The brood lac may be gathered without any danger a whole fortnight before the young larvæ swarm out, so that there is always time enough to plant them on any number of trees.

The wood of the tree on which the brood lac is to be tied should not be harder than the wood of the tree from which it has been taken off; otherwise the larvæ may not be sufficiently powerful to draw nourishment from the new host. On the other hand, brood lac from harder-wooded trees may generally be safely propagated on a softer-wooded one.

As soon as the larvæ issue forth from the lac, they crowd over the whole crown, attaching themselves to wherever the bark is soft and juicy enough and soon covering the entire length of the twig with their incrustations. The male larvæ swarm out, attach themselves to the host, and begin to form incrustations round themselves exactly like the female larvæ. But when they become mature, they leave their cells to impregnate the females, now also mature. This exit of the perfect males must not be mistaken for the swarming of a young brood; lac broken off at this stage would be utterly worthless both for propagation and for sale.

The lac insect is extremely sensitive to low temperatures and to dry heat. It has also many enemies. Ants invade lac-bearing trees in numbers for the sweet excretions. They bite off the ends of the white filaments and thus prevent a sufficient supply of air from reaching the insects; but they are easily kept off by surrounding

the foot of each tree with wood-ashes or by tempting them with other more attractive food. Monkeys also break off and chew the incrustations for the same sweet substance and injure more than they can eat. The larva of a moth (*Galeria?*) bores through the cells, devouring the juicy females. A Tinea also works its way into the cells and eats the colouring matter. No mode of protection has yet been devised against these two last pests.

What is not required for propagation is sold. This lac also is gathered before the young brood can make its appearance and exhaust the dye. In this unprepared condition the lac is technically called *stick lac*. To obtain the dye, the stick-lac is passed under a roller in order to detach the incrustation from the wood which it surrounds. The small portion still remaining is picked off with the hand. The separated lac is then crushed and washed in water, which effectually removes all the dye. The water is strained and the dye allowed to settle, precipitation being assisted by an admixture of alum or lime. The water is drawn off and the sediment collected, pressed into cakes, and dried in the sun. Cotton wool is often saturated with the dye and used by confectioners for colouring sweetmeats, and by women for rouging their hands, feet, and faces. Since the introduction of aniline dyes, the demand for lac dye has become insignificant.

The resinous portion or real lac (in this condition termed *seed lac*) is dried and placed in a long bag of fairly close-woven cotton drill. The bag is held by two operators over an open charcoal fire, which melts the lac inside. The men, one at each end, now begin to twist the bag in opposite directions, so that the melted lac is forced through the cloth and drops into a long trough underneath. From this trough, which is hot enough to maintain the lac in a molten condition, a third operator throws a ladleful on to a smooth hollow cylinder of porcelain or metal filled with warm water. Without any delay a fourth operator quickly spreads the lac evenly over the cylinder with an aloe or plantain leaf. The sheet of lac is at once lifted off, and waved about in the air for a moment or two until it is quite crisp. This is the *shellac* of commerce. The cylinder is kept warm to prevent any portion of the lac adhering to it. In Bengal, the shellac is often solidified on plantain stems. If, instead of using the cylinder, the melted lac is dropped upon a smooth plane and assumes the shape of small ginger nuts, it becomes *button lac*, which generally commands higher prices in the London market than shellac.

Schleichera trijuga furnishes the most valuable product, a bright amber-coloured lac. The lac of *Butea* is reddish.

The total inland trade in lac in India proper, carried by rail and river in 1888-89 was composed as follows :—

Stick lac,	.. 200,000 maunds,	worth	36 lakhs of rupees.
Shellac,	.. 125,000 "	"	65 " " "

In India lac is used in the manufacture of bangles, lacquer ware, varnishes, and sealing wax ; in Europe for the preparation of spirit varnishes, cements, lithographic ink, and sealing wax, and for the stiffening of hats.

SECTION II.—SILK.

Perhaps no country in the world is so rich in indigenous silk-producing insects as India, the number of species exceeding thirty. They are divided by F. Moore into—

I.—THE MULBERRY-FEEDING GROUP, represented by the various domestic Bombyces and by the wild *Theophila*. *Theophila Huttoni* is abundant in the North-West Himalayas, but Mr. Cotes says : "It has not been found possible to rear the worms successfully in captivity, and the silk is not made use of commercially at present. The worm is bivoltine in Mussoorie." The name of the group is misleading, as several species feed on other Urticaceous plants : thus *T. religiosa*, the *jori* of Assam and *deo-mooga* of Cachar, lives on *Ficus bengalensis* and *religiosa*.

II.—THE ALTAS AND ERI GROUP, comprising the genus *Attacus*. *A. Altas* is found in many parts of the empire feeding on a variety of trees. It is not cultivated, but its silk, when procurable, is highly prized. The eri silk, possessing little lustre and not capable of being reeled, but extremely durable when woven, is produced by *A. Ricini*, which is entirely domesticated.

III.—THE ACTIAS GROUP.—*A. Selene* is found in many parts of India on *Pieris ovalifolia*, *Coriara nepalensis*, cherry, walnut, *Odina Wodier*, &c. Mr. Cotes says that no use is made of its silk.

IV.—THE TUSSER AND MOOGA GROUP, comprising the large genus *Antheræa*. The two most important species, and indeed the most important of the wild silk-producing moths of India, are the *tusser* (*A. Mylitta*) and the *mooga* (*A. Assama*). The former is bivoltine, the latter multivoltine, the first and last crops being most productive as well as of the highest quality. Both are largely reared in the open air, the tusser chiefly in the Central Provinces and in Chhota Nagpur on various trees, the principal of which are *Terminalia tomentosa* and *Arjuna*, *Lagerstrœmia indica*, *Carissa Carandas*, and *Zizyphus Jujuba*, the mooga in Assam on *Machilus odoratissima*

and *Tetranthera monopetala.* The trees have to be pollarded both for convenience and to produce a good crop of leaves. 24 lbs. of mooga silk per acre, valued at Rs. 110 to 130, is a good out-turn. The expense of rearing is trifling. The cocoons of both the tusser and mooga worms can be reeled and yield a valuable silk, that of the former being remarkable for its strength and durability and consisting of tape-like, not the usually cylindrical, filaments.

V.—A MISCELLANEOUS GROUP, including *Rhodia Newera*, found in Sikkim and Nepal, and *Cricula trifenestrata*, or the mango silk-worm, distributed in most parts of the empire. The silk of the former is not used, while that of the latter cannot be reeled and is not of much value.

The Inland Trade Returns for 1888-89 for India proper show a trade in home-produced raw silk valued at nearly 2 crores of rupees. The trade in silk fabrics, independently of a large local consumption, reached the figure of 60 lakhs.

SECTION III.—HONEY, WAX, AND MANNA.

Honey and wax can, for the forester, be only natural products; but, thanks to the teeming numbers and extensive distribution of our wild honey-making bees, they are obtainable in very large quantities, especially where rocky scarps and large trees abound. The combs are often as much as 6 feet long and 3½ feet broad. The usual mode of collecting the honey is to smoke off the bees, the men covering themselves with blankets and carrying a torch at the end of a pole. This practice injures the honey; but there are some tribes which possess the secret of anointing their bodies with some substance, so that not a single bee will touch them. The honey is obtained by expression. The remains of the comb are then put into boiling water, the wax soon floating on the top, where it hardens on the water being cooled. In this state the wax is known as yellow or virgin wax. The best honey in India is made by a species of Trigona, which is a small stingless bee and builds its comb inside hollow trees.

Manna or honey-dew is the sweet substance excreted chiefly by some Aphidæ. In certain, especially dry, years, these insects breed in enormous numbers, so that every tree of the species on which they live becomes infested with hundreds of thousands of them. The total amount of sweet substance excreted is then so large, that the leaves and twigs become covered with a thick syrup, much of which also falls upon the ground. The species frequented by such insects are principally gregarious conifers and

only a few broad-leaved species, such as *Elæodendron glaucum* and sál.

Honey-dew is eagerly gathered, for home consumption, by the inhabitants of the Himalayas. The encrustation is washed off the leaves and twigs in hot water, which dissolves it at once. The syrup is then strained and boiled down to the consistence of honey, for which it may be easily mistaken by its appearance. A considerable proportion of the honey-dew crytallises at ordinary temperatures.

SECTION IV.—HIDES, HORNS, BONES, AND IVORY.

Every year thousands of cattle die inside our forests, the carcasses remaining unappropriated by the Hindu owners. Unless arrangements are made to secure the hides without delay, carrion-eating birds and quadrupeds soon destroy them and valuable raw material is thus lost. Excluding Burma, the inland trade during 1888-89 in raw hides amounted to 75 lakhs of rupees and in leather to 83 lakhs. These figures leave out all local consumption, which is worth many times more, since every village has its tanners and nearly every village its shoemaker. In the same year Calcutta alone exported to inland places 30 lakhs' worth of leather goods.

The horns of the dead cattle, especially if they are buffaloes, are also worth collecting. There are, at present, practically no workers in horns in India, but there is a large export trade in them to Europe (about 65,000 maunds, of an aggregate value of 9 lakhs of rupees), and the day cannot be far distant when combs and other articles will be extensively manufactured from horns in India itself, instead of the raw article being sent out of the country or allowed to perish in the forests and on the outskirts of towns and villages.

The so-called horns of deer contain no horny matter at all, but consist entirely of bone and really constitute an inferior kind of ivory. A small quantity of deer horns that have been shed can be collected in almost every forest and would command ready sale. As regards ivory, since the number of elephants is kept down by the kheddah operations, and elephants live to a great age, the annual find will always be insignificant and irregular.

Bones are used for buttons, handles of knives, &c., and are also ground into meal for manure. A large export trade to England in bone-meal has recently sprung up from Bombay and Kurrachee and along the routes leading to those ports. The total exports from the country amount to about 50,000 tons a year. The price of the meal in Bombay is Rs. 35 to 45 per maund. As yet the Indian

ryot is too prejudiced to use bone manure, but before long the prejudice will disappear, and then every scrap of bone lying in the forest will become marketable.

The best way to dispose of the products grouped under this head *is to give out annual leases for their collection*, but great care must be taken that the animals are not poisoned or shot by the lessees.

SECTION V.—HUNTING AND FISHING.

In all advanced countries a considerable income is derived by the owners of forests and streams from hunting (including snaring and trapping) and fishing; and, where dangerous animals abound, special arrangements are maintained by the State for their destruction. Two principal causes have hitherto militated in India against the introduction of laws to regulate hunting and fishing: (1) the great abundance of game and fish in comparison with the wants of the apathetic population, and (2) the unwillingness of an important section of the community to submit to restrictions in the matter of sport. An excellent beginning has, however, now been made in the Central Provinces and Madras, close seasons have been declared for certain descriptions of game in most provinces as far as the State forests are concerned, and numerous municipalities treat some kinds of dead game as contraband during the breeding season. Fire-conservancy has also operated in the preservation of game and fish by closing the conserved forests during nearly half the year, and thus affording game a safe retreat and protecting the higher reaches of rivers from molestation. Circumstances are thus ripe for extended imperial legislation, which cannot be undertaken too early, and which the Supreme Government have already under their earnest consideration.

In regulating hunting the following general points, amongst numerous others of a more special or local character, must be kept in view:—

(1). *Separate rules must be made for animals dangerous to man* and cattle. If such animals cannot be exterminated, their numbers must be kept down as low as possible; hence special facilities should be given for their destruction, and rules must be relaxed and large discretionary powers given to the superior local officials in the case of rogue elephants and man-eating *Felidæ* and *Canidæ*. Where *dangerous animals abound, the District Magistrate or* Divisional Forest Officer may surely be empowered to organize and conduct annual expeditions for their destruction, a reasonable budget grant being allowed for necessary expenses. Forest con-

servancy, by affording increased cover and protection and a larger supply of food, favour in a remarkable manner the multiplication of elephants and beasts of prey. The rewards offered for killing dangerous animals must be adjusted to the urgency of their destruction: a single tariff for an entire province and sometimes even an entire district is a mistake. Solitary wild boars not unfrequently become dangerous enough to require being specially marked down for destruction.

(2). All vegetable-feeding mammalia are harmful to field crops as well as to forest growth.* Pigs will break through almost any fence, and deer and antelope will clear most obstacles that can be put up to stop them. Limitation of their numbers is, therefore, in the interests of all. Their total annihilation would be a mistake, for by their presence the ravages of the large beasts of prey amongst men and live-stock are restricted, and they supply a large part of the population with meat, and provide an innocent and absorbing pastime, than which nothing better can be conceived for developing sense of locality, powers of observation, capacity for endurance, fertility of resource, self-control, and promptitude of judgment. Moreover, the right of hunting them may be sold for a sum of money large enough to more than cover the risks arising from their preservation. In the case of deer and antelope no hunting should be allowed during the rutting time, and the killing of females should be forbidden during the entire breeding season, which extends roughly from 1st July of one year to 1st March of the following year. After a careful study of the habits of the animals and the capacity of the forests to yield them food without suffering real harm, the number of full-grown males and females to be preserved in each forest should be fixed, all above this number being considered legitimate quarry.† If the actual numbers are under this minimum, no hunting should be permitted until its figure has been reached. In the case of forests bordered by extensive cultivation, the safety of the fields must also be considered in fixing the head of game to be maintained, but their ravages will usually be found confined to a very narrow belt of cultivation, and the owners of fields lying within this belt will in any case find their compensation in a lower assessment of land revenue. As

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* Elephants are under the protection of a special Act, and the Forest Department can only suggest their being caught when they have become numerous enough for a kheddah.

† This may sound unsportsmanlike, but our concern is with the good of the country—forestry first, sport afterwards.

regards pigs, they are so prolific that, in the present condition of the country their numbers can seldom be kept down without the help of one or more large battues a year, in which every neighbouring villager should be invited to join. The organisation of such battues will cost no money, as most people will be only too glad to get meat free and enjoy the pleasure of the sport, and every one will do his best to get rid of a pest that ravages his crops.

(3). The destruction of birds other than game and edible birds should be forbidden, and for these latter a close season should be observed, long enough to allow the young to be sufficiently grown to take care of themselves. The Central Provinces Government, acting on the advice of that accomplished sportsman and naturalist, Mr. R. Thompson, has adopted the following limits for the various game and edible birds :—

1.	Sand grouse, ...	... 1st October to 31st May.
2.	Pea-fowl, ...	... 1st March to 30th November.
3.	Jungle fowl, ...	... " " " "
4.	Spur-fowl, ...	... " " " "
5.	Partridge, grey and painted,	1st June to 30th November.
	" black,	... 1st January to 30th November.
6.	Quail, ...	... 1st May to 30th November.
7.	Bush-quail, ...	... " " " "
8.	Bustard-quail,...	... " " " "
9.	Bustard, ...	... " " " "
10.	Lik-florikan, ...	... " " " "
11.	Spurred goose,	... 1st June to 30th November.
12.	Goose-teal, ...	... " " " "
13.	Whistling teal,	... " " " "
14.	Grey duck, ...	... " " " "
15.	Green pigeon,	... 1st February to 31st July.
16.	Blue rock-pigeon,	... 1st November to 30th June.
17.	Doves, ...	... 1st November to 31st May, but for *Turtur senegalensis*, 1st February to 31st July.

Most birds are the forester's friends, and should, therefore, be carefully protected by him.

(4). The practice of snaring of birds in the vicinity of large centres of population should be discouraged or even put down as much as possible.

(5). For the destruction of a proclaimed animal, such as a man-eating tiger, rogue elephant, &c., three lines of action offer themselves. Either the local officials may organize an expedition,

or a single individual or party may receive exclusive permission to hunt it, or numerous parties acting independently of each other may be allowed to pursue it. The first system is obviously the most likely to succeed and exposes the forest to the fewest risks. Failing it, the second system is to be preferred, but the forest officer must assure himself that the individual or party commands all the necessary resources for success.

(6). *For the destruction of ordinary game*, the right to hunt in a specified locality may be leased to a single party, or all may be allowed to come who obtain a permit to hunt. The country is at present not advanced enough for the general adoption of the former alternative, which is without doubt the one to strive for, as it fixes responsibility and the wealth and position of the single lessee are a guarantee of his good faith. In adopting the other alternative a reasonable fee should, whenever possible, be charged as the price of the permit. The amount of the fee should be regulated principally by the value of game in the locality, the accessibility of the forest, and the number of applicants. If it is desired to limit the number of applicants, high fees should be charged. The fee may be fixed for the whole year, or the year may be divided into periods, the scale of fees for the several periods being proportionate to the dangerous nature of the season for forest conservancy and the convenience of the time of the year for seeing and tracking game. The levy of the fees should be based on the number of "effective guns" with the party, *i.e.*, the number of persons carrying and using guns. The number of elephants used in hunting should also be taken into account, and a certain fee charged for each such elephant. All other things being the same, the success of a hunt will depend on the number of elephants used, and sportsmen possessing the means to employ elephants are *ipso facto* able to pay higher fees than other people. Moreover, elephants crush and break a good deal of the forest growth, besides grazing as they move along. On the other hand, sportsmen mounted on elephants have less temptation to fire the grass, and are more to be trusted than the majority of those who cannot afford the use of elephants. The fees should in any case be high enough to leave a reasonable surplus after paying for additional establishments required by the increased supervision necessary for controlling the hunting. Every large hunting party should be accompanied by a trustworthy official, whose special duty will be to look after the followers and prevent acts endangering the safety of the forest, particularly when the party is encamped inside the forest.

Fishing is very much more easily regulated than hunting. It involves but little, if any, risk to the forest, and is limited to definite lines, and may often even be restricted to certain lengths of the course of a stream or to pools and tanks. Hence the sole object to be sought in prescribing rules for fishing is the preservation of the fish, and to this end the poisoning or damming up of water should be absolutely prohibited and a minimum size of mesh should be fixed for fishing nets. A close season may also be prescribed for fishing generally in special spawning grounds or for particular kinds of fish everywhere. For purposes of revenue, the right of fishing may be leased or a certain fee may be levied per net or rod. In the rains, when the rivers are in flood, the water-courses that are at other seasons dry, become rapid torrents, and fish come up them in shoals and are easily clubbed. From people who thus club fish and from those who catch fish by torchlight from under stones and boulders it will always be difficult to collect revenue. The latter practice must, however, in most cases be forbidden.

CHAPTER IX.—MINERALS.

Numerous mineral products are obtained from forest areas. The principal of these are building stones, which may be either for cut-stone or for rubble (including boulder) masonry; flagging and paving stones; slates; metal for macadamised roads; gravel and sand; lime-stone for mortar and plaster; gypsum, kaolin and potter's clay; talc and mica; coloured clays for plastering and dyeing; peat and lignite; ores; and gold; and so on. These various materials may be obtained either (1) by quarrying, or (2) by cutting down or breaking up a hillside, or (3) by collecting off the surface of land producing or capable of producing forest, or (4) by gathering from stream beds. The second of these methods is an extremely destructive one, unless the portion of the hill to be cut away is judiciously chosen and is of limited extent, and the stones removed are not allowed to be rolled down the hillside. The danger is greatest in loose sandstone and metamorphic formations, especially when only particular strata are exploited, in which case the removal of these strata necessarily undermines those overlying them. Unless precautions are rigidly enforced, any kind of vegetation on the hillside will become impossible and the safety of the hillside itself will be threatened. The third method, which is very commonly resorted to in broken country of trap and sandstone formation, is always harmful. As the stones lie about everywhere, their collection and removal to central export depôts result in much damage to forest

growth of all ages. Quarrying into the earth is much less dangerous than the two methods just referred to; but unless regular metalled roads or tramways are made to the quarry, the constant going to and fro of heavily laden carts will do damage to a large extent of surrounding forest. The least dangerous of all the four methods is collection from the beds of streams; the materials being taken in small quantities from a great many points all along the course of the stream, there is never any dangerous concentration of traffic.

If kankar or any other limestone is used, burning it on the spot secures economy both of fuel and carriage. The kilns should be *constructed only on open sites some distance from good forest* growth. The most convenient mode of levying payment, when the utilization is on a large scale, is to lump up the price of the firewood and stone together and to charge a fixed rate for one burning, *according to the capacity* of the kiln. By this means the worry and labour of frequent measurements and of watching against unpaid removal, as well as all chance of disputes, are effectually avoided, and no premium is offered on careless or unskilful burning. In the dry shallow beds of streams issuing from the Himalayas, numerous pebbles and boulders of limestone are annually brought down by the floods during the heavy rains. They are collected without trouble, and yield excellent lime which is much in request. This limestone is best sold by leasing for a lump sum, *for a whole year or season, definite lengths of the* stream course, and then the price of the fuel should be separately recovered at so much a charge according to the capacity of the kiln.

The exploitation of ores *will nearly always be effected* on the same basis as that of limestone. Iron-smelting, on a small scale and according to most primitive methods, is carried on in many of our forests.

In several of our rivers washings of the sand yield a small quantity of gold. As it is impossible to check the quantity collected, each collector should be made to pay a certain fee per month or season, according to the richness of the sands.

Stones for building, paving and road-material, and other minerals are best sold by measurement, although exceptional cases may occur in which the levy of a fixed rent will be found preferable.

PART III.

MINOR FOREST INDUSTRIES.

The only minor forest industries that will be dealt with in this Part are—

I.—Charcoal-burning.
II.—Manufacture of cutch and katha.
III.—Distillation of sandal-wood oil.
IV.—Preparation of turpentine products.
V.—Impregnation of timber with antiseptic substances.

Several petty industries have already been briefly described in Parts I. and II.; as, for instance, the manufacture of tar at page 147, Vol. XVI., the distillation of teak and deodar oil at page 17, and so on. In the course of a few years the number and extent of these minor forest industries in this country are certain to undergo an enormous expansion, requiring the employment of hundreds of thousands of the population.

CHAPTER I.—CHARCOAL-MAKING.

If wood is burnt with free access of air, there will be nothing left of it but a small quantity of ash varying, for most of our species, from ½ to 2 per cent. of its dry weight. If, on the other hand, air be entirely excluded and the wood subjected to a temperature of 300° to 350° C., a number of liquid and gaseous products will be given off, what remains behind being charcoal. Charcoal-making, or the carbonisation of wood, is thus only a process of destructive distillation. In this process all the moisture, most of the oxygen and hydrogen of the wood, and about half the carbon are expelled, so that the charcoal consists of the remaining carbon, oxygen and hydrogen, and all the ash elements, the carbon constituting about 90 per cent. of the whole. Actually the charcoal-burner uses wood with its bark on, the result being a somewhat larger proportion than 10 per cent. of elements other than carbon.

As just said, more than half the aggregate quantity of the combustible elements, *viz.*, carbon, oxygen, and hydrogen, is lost in carbonisation. But, on the other hand, the advantages gained are numerous and important. In the first place, the heating power of charcoal is very nearly twice that of the same weight of wood, being

just a little inferior to that of English coal and nearly equal to that of Indian coal. In the second place, charcoal is easier to light and maintain burning than wood, and gives out a very much more steady heat. In the third place, charcoal makes a clear, smokeless fire, and on this account is preferable, for metallurgical purposes, to coal in the production of the finer varieties of iron and steel. In the fourth place, it is always ready for immediate use, whereas wood has to be cut or split up to convenient sizes. In the fifth and last place, in addition to being so very much more effective and convenient a fuel, it is less than a quarter of the weight of the original wood and less than half the bulk, so that it can stand very much longer carriage (at least three times as long) than wood, and thus enables us to utilise the small produce of distant forests that would otherwise be quite unsaleable and have to be left behind in the forest to feed forest fires, favour the unchecked multiplication of destructive insects and fungi, and impose a forced limit on the improvement of the stock.

There are numerous methods of making charcoal, but they may all be reduced to three main systems, according to the care taken to exclude air. These three systems are (1) carbonisation in retorts and close ovens, (2) carbonisation in ordinary kilns, and (3) carbonisation in open pits.

Whichever method is adopted, it is necessary that all the wood in process of carbonisation should be converted into charcoal as nearly as possible simultaneously; otherwise those pieces which were carbonised first would become partially or wholly consumed, or would at any rate deteriorate under continued exposure to the intense heat, while the carbonisation of the remaining wood was being completed. *Hence, woods of very different densities, as well as* pieces of very different thicknesses, should never be mixed together. There is also another objection to carbonising woods of different densities together. The quality and, consequently, also the use to which the charcoal is put, depends to a great extent on the density of the wood; so that the different qualities of charcoal should be kept apart from the beginning, as it would be impossible *to separate them afterwards. Very thick pieces must, in any case, be* split up in order to hasten the carbonisation, and the thicker billets may also be split up so that they may be carbonised with thinner ones. The pieces to be carbonised should be dressed straight, in order that they may pack close together. Unsound wood should never be used, as it will yield no charcoal. Lastly, if the wood is to be carbonised in retorts or close furnaces, it should be as dry as possible in order to economise both fuel and time; and if it is to be

carbonised by any other method, which requires the admission of a certain considerable quantity of air to produce the necessary temperature, it should be just dry enough to develop that temperature without burning too rapidly and being consumed to no purpose. In the latter case, the quantity of moisture allowable will be in direct proportion to the dryness and high temperature of the air, the defective nature of the covering over the kiln, and exposure to winds.

SECTION I.—CARBONISATION IN RETORTS AND CLOSE OVENS.

In every method of carbonization in retorts or close ovens the double object is sought of obtaining the charcoal and of securing the products of distillation, thus allowing no portion of the wood to go to waste.

A convenient and general form of oven used in England consists of a cast-iron cylinder laid horizontally in masonry with a fireplace below. The wood is put in at one end, which is then closed with a well-fitting iron door that is carefully luted to render it completely gas-tight. For the first two or three hours the fire is kept low to dry the charge of wood. It is then driven hard until carbonization is complete; but if the operation is conducted too quickly, the yield of charcoal may be reduced by as much as 30 to 45 per cent. A charge of 100 stacked cubic feet of wood requires 12 to 13 hours to give the best results. During carbonization the following process takes place. First, the free moisture of the wood is driven off; then, as the temperature is raised and decomposition of the wood occurs, acetic acid and water are given off, followed by tar and volatile oils, and lastly by uncondensable gases, *viz.*, carbon monoxide and dioxide, and marsh and olefiant gases. The products of distillation escape through a pipe at the other end, whence they pass into the condenser. The condenser pipe gets rapidly clogged with tarry matters; it must therefore be composed of short straight lengths that may be speedily cleaned out. At the exit end of the condenser pipe there are two outlets, through the lower one of which pass out the condensed products, consisting of water, pyroligneous acid, ammonia, tar, naphtha, and various oils and resinous matter; through the upper the uncondensable gases above mentioned, which, instead of being allowed to pass off into the atmosphere and taint it, are conducted into the fireplace to feed the fire. In order to utilise to its fullest extent the heat of the fire, the products of combustion, with the heated air, are made to circulate in an enclosed space, between the oven and the floor of

a drying room above, before passing up the shaft of the chimney. In this drying room is stacked the wood to be carbonized afterwards. Any number of ovens may be set up side by side in the same building. The condensed products of the distillation are delivered into a tank, where the tar settles down to the bottom and is drawn off, while the supernatant liquid, after the lighter tarry and carbonaceous matters which rise to the top have been skimmed off, is pumped up into a reservoir containing a solution of lime or soda to form the acetates, from which the pure acetic acid of commerce may then, if required, be distilled after admixture with sulphuric or hydrochloric acid. When the run of liquid from the condenser ceases and the exit pipe from the cylinder becomes cool, it is known that the distillation, in other words, the carbonization, is complete. The fires are allowed to die down, the door is opened, and the charcoal raked out into a deep iron waggon with a close iron cover, which is luted down with clay to prevent the charcoal from taking fire in contact with air.

In some other works in England, instead of the cast-iron cylinders, they use more or less square ovens, into which the charge is introduced in sheet-iron waggons. The waggons are filled up to about 18 inches above the sides; with the progress of carbonization the contents ultimately subside below the sides. In this method the charcoal is at once withdrawn in the waggons and thus runs no risk of breaking.

The disadvantages of the cast-iron cylinders are a liability to crack, and a larger consumption of fuel owing to the thickness of the plate. On the other hand, the wrought-iron ovens are apt to leak at the joints and doors, to warp with the heat, and to be more quickly corroded by the acid products of the distillation. The yield of charcoal in both kinds of apparatus slightly exceeds 25 per cent. of the weight of well-seasoned wood; but this of course leaves out of account the fuel consumed below the cylinder to effect carbonization.

A form of apparatus much used in France consists of a cylindrical cast-iron retort, which, after being charged and closed, is hoisted into a close-fitting brick furnace or jacket with a fire-place at the bottom. A strong air-tight cover is put over the furnace. As soon as the distillation is finished, the retort is hauled out and a fresh one put in. In another very convenient form of apparatus, M. Kestner's pattern, the retort is fixed and built round with masonry. Both patterns are very simple and less costly than the two English forms described above, but their object is principally to obtain a good yield of pyroligneous acid.

Apparatus have also been invented for distilling sawdust. Owing to its finely divided state, sawdust cannot be distilled in the ordinary retorts, as it forms a dead mass and becomes carbonised only superficially. For this reason, the sawdust is fed into the retorts very gradually, and is constantly moved on, on an endless iron band, until it finally leaves the retort at the other end in a fully carbonised condition. The charcoal is comparatively useless, but it may be made up into patent fuel.

Very successful carbonization may be effected in ovens built entirely of brick masonry and ending in a narrow chimney. Such ovens may be made large enough to take up to 6,000 cubic feet of wood. The wood is carefully packed inside, several vertical flues, filled loosely with the smaller pieces, being formed, in order to secure a free through-draught and to distribute it uniformly. Just enough air is admitted through the sole of the furnace to carbonize the wood. The products of distillation pass out into convenient receptacles through openings at the sole of the furnace. The carbonization is complete when the smoke issuing from the chimney turns from black to a bluish white.

The great disadvantage attaching to all fixed works is that the wood to be carbonized has to be carried to them, often at prohibitive expense. Hence their general inapplicability, except when the products of distillation obtained serve to cover the increased expenditure.

To overcome this drawback various portable apparatus have been devised, two of which are described below. One of these, designed with the double purpose of effecting carbonization and securing the products of distillation, is M. Moreau's patent. It consists of a cast-iron furnace, having the shape of an octagonal prism and capable of containing about 400 stacked cubic feet of wood (roughly about 120 maunds). Tubes fixed at the top carry off the products of distillation, while ingeniously designed self-acting valves at the bottom allow of the wood inside being lighted, as well as regulate the entry of air to keep up the combustion, the valves completely closing of themselves when this becomes too active. The whole apparatus can be quickly taken to pieces, and transported and set up again with ease. The carbonization is completed in 30 hours, and the yield, by weight, of charcoal is said to reach 23 to 24 per cent.

Another apparatus, the invention of M. Dromart, consists of a beehive-shaped oven, capable of containing about 800 stacked cubic feet, and composed of plates of sheet-iron which fit closely together at the edges and are supported on a strong circular iron frame. This

oven, open at the bottom, is placed over a fire-place built up with brick or clay and provided with numerous holes through which the heat from below can enter it. Some of these holes are covered over with a sheet-iron plate to moderate the heat. The oven terminates in a chimney that can be closed or opened at pleasure. The wood is stacked within the oven through a side-door. When lurid vapours begin to issue from the chimney, an event that is not long in occurring, the carbonisation is complete. All that has then to be done is to close the chimney, put out the fire under the oven, and allow this latter to cool down. The apparatus is extremely portable, and the fire-place may be built up anywhere without skilled labour.

As contrivances merely for the manufacture of charcoal, neither of these two last-described or other similar apparatus are likely to come into general use, as they can never supersede the inexpensive wholesale methods of carbonization in ordinary kilns, which can, besides, take in pieces of any size without requiring them to be split up small. Those permitting of the utilization of the products of distillation must, however, at no distant date, enjoy a certain extended application in India in meeting the large demand that is sure to arise for acetic acid, wood spirits, ether, creosote, tar, &c.

SECTION II.—CARBONIZÀTION IN ORDINARY KILNS.

In every system of carbonization in ordinary kilns, the covering over the wood is a rough one (generally of leaves and earth), the wood in the kilns has to keep up its own combustion, and the emplacement of the kiln is not in any way built up.

There are numerous forms of such kilns, but only four of them, which are simple to build and manage, and are thoroughly practical and in very general use, will be described. They are (1) the paraboloidal over-ground kiln, (2) the paraboloidal pit-kiln, (3) the hill kiln, and (4) the prismatic kiln.

ARTICLE 1.—THE PARABOLOIDAL OVER-GROUND KILN.

The shape of the kiln, when it is ready to be fired, is very nearly a paraboloid of revolution, the formula for the contents of which figure is $\pi r^2 \times \frac{h}{2}$, or, expressed in terms of the circumference, C (which basal dimension alone can be measured), $\frac{C^2h}{8\pi} = \frac{C^2h}{25 \cdot 12}$. As the kiln is generally more acute than a paraboloid and has straighter sides, it is usual to diminish the contents given by the formula by 4 to 6 per cent.

1.—*Size of the kiln.*

The larger the kiln is, the less will be the relative quantity of covering material used, the more limited the space occupied, the fewer the men required, and the smaller the proportion of wood consumed in producing the heat necessary for carbonizing the remainder, and hence the lower will be the cost of carbonization. On the other hand, the larger kiln requires greater skill both to build up and to manage during the burning, and produces a harder charcoal. The largest kiln of the kind made in India seldom contains more than 1,500 stacked cubic feet of wood. A very convenient size for persons possessing little skill is one containing about 600 cubic feet.

(*To be continued*).

NOTE ON THE GERMINATION OF THE KHARSHU ACORN.

In "Brandis' Forest Flora," page 480, it is stated that the seed of *Quercus semecarpifolia*, called *kharshu* by the Jaunsaris, ripens in August and germinates within a few days after it falls to the ground. This, however, is not the case in Jaunsar, and at the present time (26th July) almost all the acorns have fallen to the ground and are in different stages of germination. Some which dropped from the trees at the end of June or the beginning of the current month have nearly completed the process of germination, while others which fell to the ground only a few days ago have

not yet been able to develop the so-called taproot. Most of the acorns are one-seeded, although some of them certainly contain 2—4 seeds, as can be easily ascertained not only by breaking an acorn open, but also by the number of distinct taproot-like processes which sometimes burst forth from a single acorn.

What at first sight appears to be the taproot or an elongation of the radicle seems to me to be something more complex, and it would be very interesting to have its structure examined and explained by some botanist. *As far as I can make it out, this* pseudo-taproot appears to consist of (1) the nutrition tube, (2) the caulicle, and (3) the taproot proper.

(1). The nutrition tube (so termed by me for the sake of convenience) constitutes the upper portion of the pseudo-taproot, and extends from the base of the confer-ruminate cotyledons (still enclosed within the pericarp) to the invisible plumule which it completely encloses. Generally it is from one to four inches long, but the length varies according to the distance the whole pseudo-taproot *has to travel in order to reach the soil,* as will be explained further on. The upper portion of this structure imperceptibly passes into the two cotyledons, and it is possible, nay, probable, that it is nothing more than their petioles united together. Whatever its origin may be, and it is a matter for botanists to decide, it seems *to me to serve some important purposes in the* economy of plant-life, which will be presently noticed.

(2). The plumule, as said above, is enclosed inside the base of the nutrition tube, and is at first so small as hardly to be discernible with the naked eye; but it soon increases in size with the growth of the pseudo-taproot.

(3). The lower portion of the pseudo-taproot forms the taproot proper. It is from 3 to 6 inches long, and is enveloped in a sheath-like covering formed by the enlargement of the nutrition tube: *it is, as a rule, thicker and longer than the portion* occupied by the nutrition tube, and the caulicle has a fusiform shape, and is covered with small root fibres, which it begins to give off immediately after the process of germination is completed.

Such, in short, is the description, though a very imperfect one, of the structure generally regarded as the taproot of the kharshu seedling. I shall now say a few words about the peculiarities the seed of this tree shows in its mode of germination, as far as I have been able to observe them.

No sooner does the acorn fall to the ground than it begins to send out the complex organ just described, by the development of which the germ-plant itself is carried away from the seed. The

pseudo-taproot continues to elongate, often twisting spirally round itself, till its growing point reaches the soil. As this does not generally occur for many days after the seed has begun to germinate, and the root, before getting a proper lodgment, has often to toil through a mass of dead leaves, it is not unfrequent to find the false taproot grow to a great length before it begins to enter the ground. A great part of this length, however, is an elongation of the nutrition tube alone, the length of which, as I have stated before, varies with the distance the root has to travel in search for soil. If the soil is found close at hand, the nutrition tube is only a few inches long; if, on the contrary, the surface of the soil be remote from the position occupied by the seed, it will elongate considerably in order to reach this surface.

When once the growing point of the root has penetrated the soil to a sufficient depth, in which act it is greatly assisted by the gelatinous substance covering it, the nutrition tube ceases to elongate, the root begins to grow thicker and longer and to develop root-fibres on its surface, the portion of the nutrition tube occupied by the cauliclo becomes ruptured and the enclosed plumule bursts into view. Even before any rupture occurs, the place of the enclosed plumule can be recognised by a conspicuous protuberance. In the earlier stages of germination, however, while the pseudo-taproot retains a uniform thickness throughout, it is rather difficult to detect the exact position of the plumule.

It is now easy to assign to the nutrition tube some of its functions. In the first place it serves to carry nourishment from the cotyledons to the taproot and to the plumule in all the stages of their growth, *i.e.*, from the time they are forced out of the closely cemented cotyledons to their full development into the seedling. The tube keeps up the connection between the cotyledons and the seedling until the latter is several months old, and sometimes the exhausted shrivelled-up remains of the cotyledons are found attached to one-year old seedlings by means of the dead tissue of what once formed the nutrition tube. In the second place, it serves to carry forward the future plant to a favourable place, however unfavourably the seed may be situated. And, lastly, it is possible that the formation of the nutrition tube, by removing the plumule and the radicle to a distance from the cotyledons, saves them from the attacks of insects, which frequent the food-gorged cotyledons.

When the plumule first makes its appearance, it is a very small thing, consisting merely of the terminal bud. It, however, begins soon to elongate itself, and when it is about an inch long, it is covered with a number of scale-leaves, each bearing a bud in its

axil. The stem continues to grow on till it is 2 to 3 inches in length, when the ensuing drought and frost bring it to a state of repose; but during at least the first year of its life it does not develop the true leaves, and is a slender, delicate-looking leafless shoot. The taproot, on the contrary, grows both in length and thickness in a marked manner; and while the stem is still only a delicate leafless organ, it is not unfrequent to find the root increased to more than 6 inches in length and a quarter of an inch in diameter. At the commencement of the following spring the seedlings begin again to push up, but it is not till the rains have set in, *i.e.*, till they are nearly a year old, that they develop their first leaves. A few exceptional cases, however, occur in which the first true leaves are formed during the same year in which the seedlings germinate. During the first three or four years of their life most of the seedlings die down annually, but are soon replaced by stronger and stronger shoots, which spring up, in some cases, from buds found in the axils of the scale-leaves, but generally from those which, at an early period of the plant's life, were developed at the root-collum. These collum buds in the kharshu oak are very conspicuous and vigorous, and I have now a two- or three-year old seedling before me, which, after dying down, has sent up again three strong shoots from the root-collum. While the aërial portion of the seedling thus dies down and renews itself annually, the root underground goes on elongating and strengthening itself by throwing out a number of rootlets until it is at once able to supply a large quantity of material to the portion above ground. As soon as this stage is reached, which the kharshu, I think, takes three to five years to attain, the stem begins to grow vigorously and to develop a larger number of leaves, and the seedling is then fully established.

In order to enable you to verify the results of my observations I am sending you a number of kharshu acorns in various stages of the process of germination, two or three yearlings, and some established seedlings.

The fact that the acorn, after the pseudo-taproot has sufficiently elongated itself, contains merely the two cotyledons firmly cemented together seems to me of great practical importance, and one which should not be lost sight of in raising the kharshu artificially. The practice at present is to cover up the seed with earth to a depth of one or more inches. This places the cotyledons in an unfavourable situation which nature never intended them to occupy, and in which they cannot get the amount of heat and oxygen required for the conversion of the nutritive substances contained

in them into materials that can be forwarded to the points where growth is to go on. The consequence is that they soon decay, and the germ-plant being thus deprived of its only source of food-supply perishes also. But if the seed is merely placed on the surface of the soil, without being covered with earth at all, the cotyledons get all they require of warmth and air, and are thus able to feed the germ-plant through the long nutrition tube, while the elongation of this last is carrying the germ-plant to a favourable place for its ultimate attachment and entry into the soil. I am of opinion that it is to a want of knowledge of the physiology of the germination of its acorn that so large a percentage of failures in the kharshu sowings of 1887 and 1889 in the Mohna Block are due.

DEOBAN :
26th July, 1890.

KESHAVANAND.

EDITOR'S NOTE.—We have examined under the microscope the specimens sent by the author, whom we must heartily congratulate on his discovery of a most interesting peculiarity of germination that, strange to say, had never been noticed before by so many observant Foresters who have lived for years in the midst of kharshu forests. He is quite right in his conclusions as to the difference of nature and constitution between the upper and lower portions of what looks like the whole taproot. Above the level of the enclosed plumule the fibro-vascular bundles are arranged exactly as in the petioles of the foliage leaves of the same tree, and there can thus be no doubt that this portion consists simply of the united petioles of the cohering cotyledonary masses. Its tubular structure is easily explained. Before germination begins the plumule is situated at the base of, and between, the two joined cotyledons. When, therefore, the united petioles lengthen, the plumule, which is attached to their base, is carried down with the base while still enclosed between them; hence the continuous cavity beginning from the base itself of the cotyledons. The root nature of the portion below the level of the plumule is obvious from the presence of the axile bundle.

Thus in the kharshu we have a wonderful natural adaptation for ensuring successful germination under the doubly adverse condition of (i) an extremely short season of vegetation preceded by a severe winter and followed by a dry autumn, and (ii) of a thick covering of moss, *Strobilanthes*, &c., and dead leaves interposed between the germinating seed and the true soil. The elongation of the petioles of the cotyledons* carries the germ-plant to a point where the taproot can enter the soil, and the tube formed by the united petioles protects the enclosed plumule until the seedling has fixed itself in the ground. This accounts for kharshu seedlings being found even in the midst of the thickest growth of herbaceous Strobilanthes. Even when the plumule has burst through the petiolar tube, it develops no foliage leaves, but simply a short thin stem with scale leaves and buds at their axils, which buds, with rare exceptions, produce the first foliage of the seedling only at the beginning of the next season of vegetation, being dor-

* We have a similar case of elongation in the cotyledonary petioles of the sál, but there, as the cotyledons are always separate, the petioles are never united.

mant in the meantime; in other words, the developed plumule assumes at once a true *winter aspect*, a further natural adaptation for the protection of the young seedling where the short season of vegetation is abruptly followed by a dry autumn with chilly nights and a rigorous winter.

The author's remarks regarding the proper mode of sowing the acorn are fully justified by theoretical considerations. During the whole of the first season of vegetation and for the development of the foliage leaves at the commencement of the next season, the seedling is entirely dependent for its growth on the food stored up in the cotyledons, and unless the cotyledons are freely exposed to air and the warmth of the sun, the stored-up food cannot undergo the necessary changes to render it soluble and thus transportable to the growing seedling.

THE BHALKUA BANS (*BAMBUSA BALCOOA*) OF BENGAL.

DURING the late summer vacation, I passed the time very pleasantly and profitably in observing, among other things, the rate of growth of bamboo culms in a village in the district of Jessore in Bengal, and in inquiring into the singular traffic in bamboos carried on by a few villages round Jhinkargacha on the Kapatak (Kapotakshi) with traders in Patna and other towns of Behar.

For those who have not been in Bengal, I may, by way of preface, state that every village in Bengal may be looked upon as a small naturally-grown mixed forest, in which every stage of the struggle for existence, the effects of light and shade, of deficiency or excess of moisture, and other conditions affecting growth can be studied at leisure. Indeed, to a person stationed outside, the appearance of one of these villages is that of a dense mass of trees of various species, palmyra and cocoanut towering above all the rest, with here and there the gables of a two-storied building, should there be any in the village, peeping out curiously through the rich foliage, the low thatched mud huts, which form the bulk of dwelling houses, being entirely hidden under the mass of vegetation. Such woods are thus a truer epitome of a large natural forest than similar plantations elsewhere can be.

First, as to the rate of growth of bamboo shoots. The clump I selected for study was one of *Bambusa Balcooa* growing on a rich sandy loam under the dense canopy formed by two individuals of a gigantic tamarind tree, *Diospyros embryopteris*, and a few *Amoora Rohituka*, while a thick undergrowth of *Clerodendron* and other shrubs surrounded it on all sides.

As my stay was not long enough to admit of my making measurements at every successive stage of growth on one and the same

culm, I had to experiment on several culms representing the several stages of growth up to a height of 26½ feet. I could not go beyond this height, for the simple reason that no shoot had attained this height before my departure.

The measurements are tabulated below :—

Days.	*Daily amount of elongation in inches of shoots.*				Remarks.
	Up to 6 in. high.	From 6 in. to 8 feet high.	From 8 feet to 10 feet high.	From 10 feet to 26½ feet high.	
20th June, ...	0·15	0·50	1·80	4·40	Day.
		1·05	4·25	8·50	Night.
21st " ...	0·20	0·65	2·00	4 90	Day.
		1·15	5·00	9·80	Night.
22nd " ...	0·32	0·95	3·25	6 50	Day. Rainy and cloudy days.
		1·25	5 10	9·80	Night.
23rd " ...	0·45	1·10	4 00	7 20	Day.
		1·30	5·50	10·20	Night.
24th " ...	0 60	1·25	4·50	8·00	Day.
		1·50	5 60	11·00	Night.
25th " ...	0·78	1·00	3·30	6·70	Day.
		1·80	6·30	12·00	Night.
26th " ...	0 95	1·10	3·50	7·50	Day.
		2·15	7·00	13·50	Night.
27th " ...	1·20	1·25	3·75	8 50	Day.
		2·50	7·20	14·50	Night.
28th " ...	1·35	1·35	4·10	10·00	Day.
		2 85	7·75	16 20	Night.
29th " ...	...	1·60	....	11·80	Day.
		4 00	...	18·00	Night.
	6″·00	30″·30 =2·525 ft.	83″·90 say 84″=7′	199″·00 =16·58 ft.	

The preceding figures corroborate in a very striking manner the important physiological fact that more elongation takes place at night than during the day, and that on rainy and cloudy days, when sunlight is least effective, the difference between day and night increments is least.

Now as regards the next subject of this short paper. In the group of villages collectively known as Gadkhali and in a few others near Jhinkargacha, a certain class of the inhabitants have from time immemorial been engaged in the singular occupation of bending young bamboo shoots, while still in the clump, into the

form of a shallow *U* in the middle. The bending is effected, as the tender shoot grows, by means of ropes attached at various points and secured to old unbent shoots of the same clump, the ropes being tightened or loosened from time to time, as the necessary degree of curvature at each point requires. No little skill is required to give the proper curvature without breaking the shoot. The shoot is headed down at the end of the first year at a height of about 25 feet from the ground.

When the bent culms are three years old, they are ready to be cut. The villagers themselves do not cut the bamboos, but sell them standing to the traders, who come nearly every winter from Behar to cut and take them away.

It will now be asked why the bamboos are so bent and what purpose they serve? In answer to my questions I was told that in Behar (and probably also in the western districts of Bengal proper) no marriage can take place without the bride and bridegroom being carried about, on one of the days over which the ceremony extends, publicly in the streets in a special open palanquin (dandy or tonjon). The body of the palanquin is boat-shaped and contains two seats at opposite ends facing one another, and it fits into the U of the bamboo, the more or less straight end portions (6 to 8 feet in length) being supported on the shoulders of the bearers. Each seat is wide enough to accommodate at least two persons. In the palanquin the bamboo is either fantastically painted or carved or otherwise decorated.

Some years ago such bamboos used to fetch in the clump as much as Rs. 60 and even more a score. The trade is not so brisk as it used to be, and the price per score has fallen as low as Rs. 20 to 25. The unbent shoots nevertheless still command a lower price, about Rs. 20 the score.

The bamboos are taken to Behar in rafts lashed on each side of a boat. The course taken is down the Kapatak and some other streams into the Ganges, thence up the Ganges to destination, an average distance of about 600 miles following the curves and bends of the rivers. They have never yet been sent by rail, probably because they are too long for ordinary wagons.

In spite of the long transit, with the profits of the importer and the palanquin-maker added on, their ultimate selling price must, notwithstanding the present low rates at the places of production, be still very high.

FOREST SCHOOL:
21*st July*, 1890.

UPENDRANATH KANJILAL.

A NOTE ON FOREST MANAGEMENT IN TINNEVELLY.

Coppice Coupes for Fuel, &c.

The Tinnevelly District is in the extreme south of India, and its rainfall ranges from about 20 inches in Tuticorin to about 200 inches on the water-parting, which is the boundary between it and Travancore, elevation averaging from 3,500 to 7,000 feet.

Up to the last three years it has, in common with other Forest Divisions in Madras, employed the so-called Thanadar (*Rawanna* in the North-West Provinces) system for the issue of permits for small timber, fuel, bamboos, charcoal, grass, and other produce.

Within the last two years, however, this system has almost entirely been done away with; and as the district is the only one in the Presidency which has attempted, what I hope will be evident, is a great advance in every way on the promiscuous fellings which obtained under the Thanadar system, I am justified, I think, in giving a brief résumé of the method now in practice.

To begin with, I must state that everywhere where we have opened coupes the forest is more or less scrub, with, in places, very poor growth of teak and vengai (*Pterocarpus Marsupium*), reminding me very much indeed of the Beribara coppice in Saharanpur, the component species, with the exception of the two above mentioned, being almost identical. The rainfall is probably on an average 50 inches. The soil is poor and gravelly with outcrop of gneiss and granite. But to counterbalance this poor growth, the demand for charcoal, fuel, even twigs and leaves, and small timber, is heavy and sustained, very little being left on the ground in an exploited coupe.

To begin with, and to make myself better understood, I am afraid I must give an outline of the system as it existed and now exists in all other districts. It differs from what is very much the same thing in Northern India, at any rate in the North-West Provinces, in having not only a Thanadar but also a Permit Gumashta, the duty of the latter being to issue tickets, and of the former to check the same at some spot where permit-holders must come to from the forest (this being obligatory under our timber transit rules), this division of labour being intended as a check upon each. The drawbacks of this system are manifold, chief among which are :—

(i). The promiscuous character of the fellings, the permit-holders being practically allowed to cut anywhere they please throughout the forest. It is true a cer-

tain locality for obtaining the produce is usually entered in the permit, but where hundreds of people daily go into the forests from different directions, it is of course impossible for the single Forest Guard in charge of thousands of acres to superintend the fellings, even if he has the wish to do so.

(ii). Difficulty of check by Forest Guards in our present short-handed condition, many Forest Guards having as many as three thanas in their beats, which comprise from 10 to 20 square miles and even more.

(iii). The great chance there is of fire occurring and the difficulty of detection, the ticket-holders being scattered over the whole forest more or less.

(iv). The impossibility of getting trees cut flush with the ground, in which case only they would furnish the best coppice-shoots.

(v). In consequence of many of the trees being cut in a leaf-canopy more or less complete, the impossibility of these coppice-shoots ever making good poles or even growing at all, as coppice-shoots notoriously demand more light than seedlings, at least in the first years of their existence.

(vi). As a consequence of (ii) the chances of illicit removals.

(vii). The cuttings not being confined to one spot, the possibility of their being done on steep hillsides which want all the growth they can bear for protection from erosion.

(viii). The great waste of wood caused by the permit-holder often cutting down a whole tree or several trees and only taking the particular portion of each which may be suitable for his particular purpose, leaving the remainder to rot or furnish food for the next forest fire, which, by the way, is often caused by these very permit-holders in order to make the forest more easy of circulation.

The above are really only a few of the most important of the multitudinous reasons which might be given. To do away with this system, favourable areas have been chosen—I mean places easy of access and affording convenient transport, which are as much as possible sheltered valleys and level ground where reproduction promises to be good. Through these areas base lines about 6 feet broad have been run, extending in some cases for six miles, and from these base lines other lines at right-angles have

been cleared, thus forming rectangular coupes of easily ascertainable areas.

These areas, generally 60 to 100 acres, have been put up to auction, and have realized from Rs. 5 to Rs. 45 per acre, depending a good deal on whether teak and vengai have been found in them or not. I have already stated that both these species are of the most inferior growth, never exceeding at the outside one foot in diameter, and for the most part twisted, heart-shaken, and distorted; but even these are eagerly sought after and converted into spokes, felloes, and poles. The system is that of coppice with standards, 15 or 20 standards of the best and straighest-grown trees being left for possible timber, or at any rate as seed-bearers. Binding contracts are drawn up with all purchasers that all trees and undergrowth must be cut flush with the ground, and the coupe perfectly cleared in a given number of months. The contractor is also held responsible for fires and illicit removals, and so far we have had no trouble in getting our work well done.

The standards are marked with tar, and hammer-marked at the base by the Forest Guards, and the rotation roughly laid down is 20 years. This number of years will probably be sufficient, as most of the forest is incapable of producing large timber, and the requirements are chiefly charcoal and fuel and small wood for house-building and agricultural instruments. The coupe rides are regularly cleared by guards and fire patrols and demarcated with stones, showing the year in which the coupe was felled, and a book is kept in the Range office showing the amount for which each coupe was sold. In some coupes it has been found possible to fell linear sample areas previous to sale, and then by stacking and weighing to determine the approximate yield. This operation is doubtless expensive, but will be eventually carried out in every coupe.

With this system we gain the following signal advantages:—

(i). Complete abolition of Thanadars and Permit Officers, resulting in a saving equal to about 20 per cent. revenue.

(ii). Fellings confined to one spot.

(iii). Hence easy check.

(iv). Less likelihood of fires occurring, as the purchasers are held responsible for keeping out fire, and, in case of occurrence, for keeping it within the limits of the coupe, the coupe rides serving as excellent bases from which to counter-fire.

(v). Improved re-growth, the original stock having been all properly coppiced.

(vi). Sufficiency of light let in both for reproduction from stools and seed, which is especially necessary in the cases of vengai and teak.

(vii). Perfect rest given to the parts not worked.

(viii). The greater care with which artificial reproduction by dibbling in seed in blanks can be carried out and results noted.

(ix). The difficulty of illicit removals, for not only is the purchaser bound to prevent the same by the Forest Act, but he is liable to forfeiture of his deposit, generally 25 per cent. of the total amount bid, if any is detected which he has not reported. All removals from the coupe are bound to be covered by a manuscript pass issued by the purchaser of the coupe, whose signature or that of his agent is registered in the Range office.

(x). Forest Guards and other subordinates given much more time for inspection of their charges and for the regular working of the more valuable high forest where selection fellings are being carried out. Moreover, if any illicit fellings are, by the connivance of forest subordinates, allowed to take place, the Forest Guard and contractor can at once be held responsible for the same, since they have not got, as at present, the excuse that the fellings were done by permit-holders.

(xi). Immunity from grazing, as all coupes are at once notified as closed to grazing in the District Gazette.

All we really want now is working plans to develop the scheme more thoroughly. These coupes are made at intervals of from 5 to 8 miles throughout the district, and are hence easily accessible to all villages.

J. G. F.-M.

FRUCTIFICATION OF THE KHARSHU OAK,

(Quercus semecarpifolia).

ON pages 318-19, Vol. XIII. of the "Indian Forester," there is an admirable note by Mr. Hearle on the kharshu oak (*Quercus semecarpifolia*) of the North-West Himalayas, and the remarks he makes therein regarding its mode of fructification are specially valuable. During the last two or three years I have had the good fortune to watch the behaviour of this tree in its real home, and, as the subject may interest some of your readers, I venture to send you some of the facts noticed by me.

Some Foresters regard this oak as deciduous, while others main-

tain that it is never leafless at any time of the year. What I have observed in the Deoban forests leads me to the conclusion that, although in a large proportion of trees the old leaves persist for some time after the new ones have made their appearance, there are always some trees which are certainly leafless for one or two weeks during the spring. This departure from the evergreen type, at least in this part of the Himalayas, seems to be dependent on the influence exercised by the nature of the soil and rock and by the aspect, gradient, and climatic variations. On deep and rich soil, on westerly and easterly aspects, on slopes with gentle gradients, as well as in sheltered ravines the tree is, as a rule, evergreen; whereas on rocky ground with very little or no soil on it, on the dry and steep, more or less southerly slopes and on exposed aspects, it is not uncommon to find a large number of trees quite leafless for a few weeks in April and May. The effects of the late long drought, which lasted from September, 1889 to April, 1890, were clearly noticeable, in that a larger number of trees were found leafless during the spring of the present year than in any of the preceding three years.

The new leaves, as a rule, come out at the beginning of May, and this is also the time for the male catkins to appear. The female flowers, however, show no sign of their presence till the middle of June following, and at this time they are so small that without a careful search they are scarcely distinguishable from the bud scales among which they lie hidden. They are found on short spikes, which spring up from the axils of leaves at the end of the current year's shoots, and generally the spikes are placed in close proximity to the terminal buds, though in some cases they occupy the axil of the second or the third leaf counting downwards from the terminal bud. It is important to bear in mind this position of the female flowers at the end of the shoots of the year, for it will be shown lower down how it may account for the long period that intervenes between their first appearance and the ripening of the acorns.

Simultaneously with the appearance of the female flowers the male catkins begin to shed their pollen, and an examination of one of the former at this time will show a number of pollen grains adhering to its stigmas. This leaves no doubt as to the fact of the female flowers of one year being fertilised by pollen from male catkins of the same year, and the supposition that their fertilisation is effected only after a lapse of 12 months by pollen from male flowers of the following year may, therefore, be dismissed as untenable. The process of shedding the pollen is completed by the end of June, and there is reason to believe that before the end of next

July all the female flowers are fertilised. It is, however, possible that some months elapse from the time the pollen-grains reach the styles to the time the pollen-tubes come in contact with the ovules, but this is a matter which can only be ascertained by means of a microscope, and which I am not therefore in a position to determine.

At the end of July, when the process of fertilisation is apparently quite completed, the female flowers are only about $\frac{1}{16}$th of an inch in diameter, and from this time to April of the following year the increase in their size is so slight as scarcely to be appreciable. On comparing two sets of female flowers from the same tree—one taken at the beginning of August, 1888, and the other at the beginning of March, 1889—hardly any difference could be found between the size of the flowers composing them. This retardation in growth is not confined to the small acorns alone, but affects the other growing parts of the tree as well. Thus the spring shoots from the beginning of August to the end of the following March make next to no addition to their length, and the terminal buds during all this time also lie in a dormant state. As soon, however, as the new leaves begin to appear at the end of April, and long before the current year's male flowers are fully developed, the hitherto tiny acorns commence to grow rapidly—a fact proving conclusively that they must have been fertilised during the same year in which they were produced—and at the beginning of July, when they begin to ripen and are ready to fall, many of them are already more than an inch in diameter. At this time may also be seen the new female flowers, produced during the current year, occupying the axils of leaves at the end of the newly-formed shoots. Though now nearly a month old, they are still very small, and can with difficulty be distinguished from the bud scales which hide them. It is, therefore, certain that thirteen months intervene between the production of the female flowers and the ripening of the acorns.

This peculiar behaviour of the kharshu seems to me to be due directly to the short duration of the period of vegetative activity in these regions of the Himalayas. At the high elevations (8,000 to 10,000 feet) where this tree grows, this period is very short, and appears, in fact, to be limited to the interval elapsing between the development of the buds into leaves in April and the ripening of the previous year's acorns in July. By the beginning of August the shoots of the year have attained their full size, and thenceforth, if any growth takes place, it is insignificant. Consequently the female flowers, situated at their extremities, are unable to develop into acorns until the commencement of the following spring, when the shoots bearing them again become active, and the little acorns

are for the first time in a position to make the necessary progress towards maturity.

DEOBAN,
26th *July*, 1890.

KESHAVANAND.

THE PROSPECTS OF FORESTRY IN VICTORIA.

I FORWARD herewith a cutting from a Melbourne paper criticising the policy proposed by the Provincial Conservator in his last Annual Report, which may be of interest to your readers. Mr. Perrin would appear to have a somewhat hard task before him, as it seems that the forests in his charge are frequented by "saw-millers," who are not restrained by the imposition of a royalty from using or misusing the State timber. The arguments against a State Department obtaining the highest price for its outturn are that such an arrangement would raise the price of timber in the colony and encourage imports; whilst the community only wish their Forest Department to make revenue sufficient to provide for the pay of the protective establishment. Quite a touching picture is presented of the State distributing gold, coals, and trees to promote the general prosperity. A more enlightened critic would perhaps wish that the general public and not only those directly interested in forests, such as traders, saw-millers, and users of timber, should profit by proper protection and management of the State forests, and agree that this can only be done when general taxation is lightened by obtaining from the forest the highest revenue possible without infringing vested interests or encouraging the much-dreaded competition from neighbouring colonies. It is interesting to note that with very little outlay a School of Forestry can be established to provide well-trained Foresters, intimately acquainted with their craft and full of local knowledge. The means of procuring these desirable results cheaply should have world-wide publicity, so that other nations may imitate and profit. The restriction of unlimited grazing and the temporary closure of over-cut areas are favourably commented on, provided the saw-miller is not vexed. Mr. Perrin will doubtless congratulate himself when he reads that enthusiasm in forest conservation is pardonable, and he may, I think, be forgiven if he wished his critic a little more of that "ardour and creditable intelligence" which, "so far as can be seen," the Conservator possesses.

OBSERVER.

"Were it possible to express in figures the capital value of the forests of Victoria thirty years ago and their capital value to-day, a clear idea might be obtained of the loss caused by the reckless and wasteful felling

of trees which has been permitted. As it is, we may only indulge in conjecture, and imagine the extent of the loss. That there has been great sacrifice in the past is, however, beyond doubt, and it justifies the efforts now being made to place our forestry system on a sound basis. The ideal and the practical are really indivisible so far as forestry is concerned, for not only is it good for us to conserve and expand our resources, so that our capital may increase, but it is possible to do so. Nature has made the soil produce trees of great value, and so abundantly that it should be easy to overtake in any one year the consumption of that year. The management of the areas specially devoted to timber-growing ought, therefore, to be on such lines as will permit of all demands being supplied, and at the same time provide for recuperation to enable the necessities of the future to be served without any difficulty. If this policy be observed we shall soon forget the follies of the past, and shall applaud the wisdom which guided the Government in making a change in administration. So far as can be seen, Mr. G. S. Perrin, the Conservator of Forests, seems to be bringing to the performance of his duties the ardour of the enthusiast and creditable intelligence. His critics are inclined to believe that his enthusiasm is not tempered, as it should be, with judgment, but that remains to be proved. Enthusiasm in the cause of forest conservation may well be pardoned. It may lead to mistakes, but no mistake should be of so serious a character as not to be capable of being easily remedied. What Mr. Perrin should feel is that, as his reforms must touch vested interests more or less severely, it is better to proceed slowly than to cause unnecessary loss to the individuals directly affected. He may, by adopting this course, postpone the completion of his work, but will at the same time ensure that the advantage he is seeking will be the more lasting because achieved without undue friction.

"In the report lately presented to the Minister of Lands, Mr. Perrin covers the time which has elapsed since he assumed his present position, and not only brings into relief the bad effect of the unscientific manner in which the forests have been treated, but directs attention to improvements deemed necessary. Everyone will agree with him in his condemnation of the administration of the past, which was worse than useless. But, while approving of most of his proposals, it is necessary to say that his scheme for obtaining a royalty on all timber cut will require much fuller consideration than it appears to have received. In principle, no doubt, it may be right to make all saw-millers pay a prescribed price for each tree felled, but there are some practical considerations which have to be taken into account. The State does not wish to make a direct profit out of its timber. It is willing to dispose of trees as it disposes of coal or gold—in such a manner as to promote general prosperity. The only reasonable stipulation should be that there must be a sufficient revenue from licenses to enable such a staff of inspectors and rangers to be

maintained as is necessary to protect the forests and prevent spoliation. So long as the department pays expenses, the community will be satisfied. But the imposition of a royalty would not only be unnecessary for purposes of conservation, but would directly tend to increase the price of timber. The saw-miller would charge the royalty to the timber merchant, the timber merchant to the builder, and the builder to the house-owner. Besides, if the market is disturbed in this way, there will certainly be a stronger demand for timber from other colonies than now exists, and our saw-millers will claim additional protection. The advantage gained by the State on the one hand would thus be nullified on the other. These considerations cannot be disregarded. They are weighty, and, so far as can now be seen, are likely to prevent the "royalty" system being introduced. Still, it is impossible to find fault with the Conservator for making the suggestion. All things being equal, it would be a good thing for the State to sell its timber at the highest price obtainable; but all things are not equal, and the scheme appears to be impracticable.

"There are several other proposals in the report in which it is a pleasure to concur. Mr. Perrin shows his enthusiasm by suggesting that a School of Forestry should be established in connection with the agricultural colleges, so that in time the colony may command the services of competent, well-trained Foresters, intimately acquainted with the principles of their craft, and particularly informed of the best means of applying those principles to Australian conditions. It will be admitted that we cannot obtain men fully equipped with knowledge suitable to our requirements from Continental schools, and therefore it is desirable that they should be trained locally. As the proposition in this respect will involve very little outlay, it is to be hoped that the Government will carry it into effect. Mr. Perrin urges that the department should be given full control of all State forests, not merely to deal with saw-millers and splitters, but to regulate their use for grazing purposes. It is possible to allow them to be so used with advantage, but it is necessary that the Rangers should have power to prevent cattle roaming at large and destroying shoots and saplings. The damage done by indiscriminate grazing must be considerable. Mr. Perrin is also right in his desire to prevent the complete denudation of the red gum forests on the Murray, and he will, no doubt, be careful to carry his proposals into effect without harassing the saw-millers operating in that neighbourhood. It seems to be necessary, in his opinion, to close some of the areas for a number of years, to enable nature to make good the ravages of man. If the necessity is as great as he represents, there should be no hesitation in following his advice. It is so obviously in the interests of the saw-millers that this prudent course should be adopted, that we cannot understand how any objections could be urged against it. It is for the Government to say whether or not this valuable timber is to be preserved."

THE FORESTS OF THE UNITED STATES.

(Continued from page 165, Vol. XVI).

II.—THE INFLUENCE OF HUMAN ACTIVITY ON THE NATURE AND CONSTITUTION OF THE FORESTS AND ON THE SOIL AND CLIMATE.

WHEN the first Europeans landed upon the shores of the New World, there lay stretched out before them an expanse of virgin forest unique in its extent, in the number of its species, and in the age and size of its trees. No slope was too steep, no soil too poor or too water-logged for producing a rich forest vegetation. Trees, the trunks of which rose up to heaven like towers, were clothed every autumn with a blaze of scarlet and crimson foliage. In the intervals between their massive trunks were crowded together smaller trees of various species, while in the rich vegetable mould formed by the decay of by-gone generations of trees and hidden from the eye by mosses or by an exuberant growth of herbs and shrubs, seedlings and saplings, the prototypes of the coming generation of trees, threw out their roots in every direction and struggled for life securely sheltered from excessive heat and excessive cold. Mineral matters, by themselves inert, but now dissolved and converted into plant-food by the powerful chemical action of the decaying vegetation, were ever streaming up from the soil into the trees to return thence, not alone but combined with organic substances, back into the soil, which thus grew richer every year. What wonder then if the new comers were struck by the marvellous fertility of the soil, surpassing all previous experience, and if they deemed such soil quite inexhaustible? They did not know that once the forest was removed, the fertility of the soil would diminish more rapidly than it had increased under the cover of that forest. Now, it is easy to see in the enlightened 19th century that a single field crop, whatever it be, removes from the soil more plant-food than the unassisted chemical processes going on within the soil can make good in a single year, so that from the moment the forest is cut and an agricultural crop substituted the soil be-

gins to deteriorate and goes on from bad to worse unless an artificial fertiliser is applied.

It is the opinion of most people that if we cut down forest and at once re-stock the land or let nature sow it, no deterioration of the soil will ensue. This may be true in the case of the very best soils, and if our methods of regeneration imitate more or less closely those pursued by nature in a primeval forest. In the case of ordinary soils, and particularly in that of poor ones, deterioration must follow, since artificial manuring is obviously not to be thought of. I myself believe that it will probably be found to be a general rule that whether the land is kept under forest or is given up to agriculture, the immediate result of such action is to cause a diminution of fertility. Agriculture may bring about this result quicker than forest exploitation, but the end will be the same in either case. The necessary outcome of such deterioration will be the gradual falling off in the vegetation of those species which make the largest demands upon the soil. Such loss of vigour will be manifest in a steady diminution of the height attainable by those species, for we know that the richer the soil is, the taller will be the forest, and conversely that, other factors of growth being the same, the height of the forest is a certain measure of the fertility of the soil. Hence the cutting down of the primeval forest and the consequent deterioration of the soil and weakening of the more exacting species must lead to those species being gradually driven out in the struggle for existence by others which are satisfied with a poorer soil. Thus the walnuts, the hickories, and the oaks must, if unassisted, disappear before the birches, the poplars, and the pines; the forests of the white and red pines round the great lakes will be replaced by an inferior growth of the black or spruce pine; the precious forests of the southern pine, the finest pine in the world, must be completely invaded by the less valuable old-field pine or the slash pine, or by shrubby oaks and the short-leaved pine.

Europe and Asia have already seen these changes of growth consequent on the spoliation and destruction of primeval forests, and North America will not be long before it goes through the same experience, which will, however, be on a far more colossal scale. The laws of Nature and their reaction upon the action of man are everywhere and at all times the same. In Europe and Eastern Asia, the original hardwood trees have at many points been displaced by pines, birches, the spruce, and tall grasses, and there are now large tracts of light sandy soil so utterly exhausted by the action of the woodcutter that they can with difficulty bear a stunted

growth of pines of little value to the owner and of no value at all from a climatic point of view, and which have constantly to struggle for bare life against the weather, against insects, and against fungi. Already in the United States, in the South and North, we have extensive stretches of such soil, mostly covered with pines, which demand the most unremitting care to preserve them in a useful condition. If the forests of the southern pine-belt are allowed to be annually ravaged by fire fed by the fallen needles and the present thin growth of tender grasses, without taking into account the wasteful methods of orcharding or cutting down the pines and the clearing of the tree-growth from a soil that could scarcely bear a few consecutive crops of agricultural plants, we need no great scientific acumen to foresee with exactness the changes that will occur in the soil and climate of that poor sandy region. The tender valuable grasses, which under the protection of the light foliage of the pine now protects the soil of the virgin forest, will disappear with their nurses, and either give place to hard useless grasses capable of standing extremes of heat and cold, or leave no trace of vegetation behind them in the desert waste. Those wide belts of white, sterile moving sands which border both sides of the railways of the Gulf States show what the poorer tracts of the country will come to, if the Southern farmers do not give up their pernicious habit of setting fire to thousands of square miles every year.

Besides the slow but steady changes indicated above, others are to be noticed in certain places displaying the immediate revolt of ill-used, usually long-suffering Nature against the unregulated action of man, *viz.*, a sudden change of flora. In Wisconsin, Michigan, and Minnesota all slight hollows and depressions within the hard-wood region are filled with spruce, balsam fir, larch, or white cedar (*Arbor vitæ*). Under the dense shade of these trees the soil is covered with a thick matting of moss, which sucks up like a sponge all the water that would otherwise lie on the surface, and which grows at the top as the lower portions die away and decay; so that with the débris from the trees above a thick water-gorged substratum is formed, in which the roots of the trees spread out and luxuriate. Remove these trees, and no new growth of the same species can spring up again; the mosses, exposed to sun and wind, dry up and perish, a stagnant pool of water collects, and either worthless shrubby alders* or light-loving, coarse, hard grasses

* The Atlantic forests possess no large valuable alders like the American Pacific and the Japanese and European forests.

(species of *Carex* and *Arundineæ*) take the place of the vanished tree-forest. Numerous spots, on which, within the memory of many living settlers, stood noble cedar and larch forest, are now already unhealthy impassable swamps. To restore the forest and render the air once more salubrious is now an almost utter impossibility.

The consequences following the deforestation of mountain slopes are too well known. The pelting rain washes down all the finest, and, therefore, most precious particles of the soil, leaving behind only gravel and stones and boulders, and reducing the bare mountain side to a condition of complete sterility, unless grasses and shrubs are in the meantime allowed to grow and overrun it and stop further deterioration.

I may be permitted here to quote an instance showing how quickly nature retaliates when her laws have been violated. Here in Japan even the mountainous districts contain a comparatively large population, and the forests yield considerable quantities of chestnuts, horse chestnuts, mushrooms, ferns, tender leaves of trees, &c., which constitute to a very great extent the food of the people in addition to the rice that has to be brought up from the lower country. Many of the slopes, even those whose gradients run as high as 45°, are denuded of their forest covering, and are in the very first year sown with Indian corn, various millets, cucumber, small beet, the egg-plant, and, to a slight extent, wheat. Heavy rain, which is common enough, washes down the rich brown and black particles of the soil, furrowing the mountain side and forming in the valleys below small torrents, which sometimes expand into a huge mass of rushing liquid mud that sweeps away before it men, cattle, houses, bridges, and the unreaped harvest.

There appears to be, between Eastern America and the eastern part of the old world, not only a striking analogy in regard to the forest flora, but also a marvellous coincidence in regard to meteorological phenomena. Thus in the summer of 1889 the people of Japan were filled with horror and dismay at the inundations which destroyed thousands of human lives and did damage to land and property to the amount of nearly 3,000,000 pounds sterling. On the 10th and 11th July, the exact dates of the great storm on the Atlantic Coast, a terrific gale raged along the eastern coasts of Japan, causing heavy damage to moveable and immoveable property.

In Japan the South-West monsoon gives heavy rain to all the numerous islands, and the quantity of good top-soil washed down into the streams and thence into the sea is enormous. On the steep

mountain slopes referred to in a previous paragraph the productive elements of the virgin forest soil are washed out within a few decades, in spite of extraordinarily heavy manuring every year. The heaps of stones picked off the fields every year go on steadily increasing, the soil becomes rapidly shallower and shallower, and finally only a scanty crop of potatoes or buckwheat can be raised before the field has to be given up and allowed to be overrun with grass, bamboos, or shrubs. These, if left untouched, prepare the soil again for trees, the pioneers of agriculture. But actually nature is rarely left undisturbed in her work of restoration; the shrubby growth is cut over every two to five years, either for green-manuring or for small firewood, and thus nearly half the mountains are completely bare of tree-growth.

Inside the forest areas of the United States stock-breeding is a great industry. The farmer opens out the umbrageous leaf-canopy* by girdling or cut out trees everywhere in order to let in light for the growth of a rich crop of grass. Many slopes of the Alleghanies have already been thus prepared for stock-raising, and if we travel along the railroads through those beautiful scenes, looking out from comfortably and luxuriously furnished "parlour-cars," the mountains, the forests, the soil, and the cattle seem in the distance to be enjoying each other's company and to be all in tip-top condition. But if we leave the railway and climb over the fences, as I have often done, and take a nearer view of what from afar looked like forest, the trees will all be found to be standing scattered away from each other and degenerating into low branches. Being such, they cannot exercise much influence upon the soil and climate, and they even seem to be unable to prevent the heavier falls of rain from rushing down and scouring the mountain sides. If we follow the browsing animals, we shall find that at every step they slip back or forward from ½ to 2 feet, thereby tearing away with their sharp moveable hoofs the soil, which is thus constantly loosened and is washed away by the first heavy fall of rain. In a few decades these slopes, if once more left to themselves, will undoubtedly refuse to grow again the walnuts, hickories, or even oaks, which composed the virgin forest; but will probably not be able to prevent birches, poplars, and pines with spreading crowns from taking possession of it, *particularly as the cattle eat greedily the seeds of the former* trees, but carefully avoid those of the latter. What a prodigious

* This, we know, is the very opposite procedure to that followed by the forest proprietor in Europe, who does his best to maintain his leaf-canopy as full as possible and thus to keep his soil in heavy shade.

change in the nature and constitution of the forest to be brought about in the course of fifty or even a hundred years by domestic animals!

We always find the finest forests on level ground, in valleys along the courses of rivers, that is to say, in the best soils, and it is such tracts that are first cleared and converted into fields. If the easiest mode of clearing away the forest is to use fire, "Use fire by all means" will say the pioneer settler, "for what objection can there be to employ the quickest means of getting rid of the heavy timber?" Perhaps many localities are too wet for field crops, "Drain them" will be his advice. But will he foresee, or, if he foresees, will he give a single apprehensive thought to the fatal consequences that must follow such an operation? The draining of the lower land will also *ipso facto* draw water away from the poorer, lighter, and looser soils below, which, being already deficient in moisture, will become further impoverished and may even become totally unfit for forest growth. In many instances the valuable broad-leaved trees will be replaced by what may be called *forest weeds*, *viz.*, birches, poplars, willows, alders, and pines. In others the white and red pine woods, which usually cover bits of rising ground within the hard-wood area of the northern forests, will degenerate or have to disappear before the invasion of an inferior pine, such as the black or the spruce pine.

The private owner of forest property naturally cuts down his best timber. Following a short-sighted policy, he removes all that can be sold or used up and leaves behind, to sow the ground and become the parents of the next generation, the unsound, crooked, and least valuable trees. Experience in Japan and other countries shows that if this new generation, which will be composed of inferior, light-seeded trees, forming a more or less open leaf-canopy, is left unmolested, under its fostering shelter will gradually appear young plants of the valuable species (from seeds dropped by birds and squirrels, if they are heavy-seeded species), and the forest will ultimately be restored to its pristine condition; but that if fire, fed with the débris of the exploitations, is allowed to sweep through the new generation, or the wood-cutter invades it year after year, then, in Japan at least, grasses and shrubs or a stunted scrub of scattered storm-beaten trees takes possession of the ground and any kind of restoration, within a reasonable time, of such areas without artificial aid becomes a hopeless matter.

The changes following upon the indiscriminate felling of forests will probably manifest themselves more rapidly in North America than anywhere else, since human activity is there far more intense

than in any other part of the world, and to this are added the indescribably wasteful methods of exploitation and a demand which always keeps ahead of the already vast supplies ever pouring in and is nevertheless alarmingly on the increase.

*It is true that the area of forests on the North American At*lantic basin is still enormous; that the great variety of timber trees, which the changeable climate, with its rapid alternations of great heat and great cold, and of damp and drought, and the vast extent of the country and the great variety of soil have produced, is not equalled in any other part of the same temperate zone, not even in the forests of Japan. But my own opinion is that the forests which receive their supply of rain from the Pacific Ocean are still better suited for the individual development of trees and can bear a heavier mass of timber than even the forests of the Atlantic basin. The height of the Sequoias, the red firs, and the sugar pines of the Pacific sea-board of America, of the Cryptomerias of Japan, and of the Eucalypts of Australia and New Zealand, is not surpassed, much less reached, by any of the trees on the Atlantic sea-board, be it of America, of Europe, or of Africa.

It will very often happen that valuable timber-yielding species, if left to themselves, will be unable to struggle against inferior kinds and against injurious climatic influences, and thus disappear before them or be left in a hopeless minority. If on low-lying ground about an acre is completely cleared of trees in the midst of a mass of forest, a striking meteorological change will be at once manifest even in that limited area. The clearing will, in the language of foresters, have become a frost-hole, that is to say, in those holes in the forest the frosts will not only be more frequent and severe, but will also occur both earlier and later in the season than in the surrounding forest. Amongst the North American species seedlings of the heavy-seeded valuable oaks, walnuts, and hickory suffer much more from frost than the seedlings of the light-seeded birches, poplars, and pines; hence in openings made in the forest the action of nature will be to favour the appearance and establishment of the least valuable species to the disadvantage of mankind. But even in those places the valuable trees, temporarily driven out, will gradually reappear later on under the shelter of the less valuable ones, if the fire-fiend, one of the plagues of the New World, is kept out.

Another cause of change in the composition of a forest is also at work, to explain which I must crave the reader's indulgence and make a slight digression into the biology of forest trees.

Within the range of distribution of a forest tree there is always

a central region in which the tree grows in its highest perfection, and which may therefore be termed the *optimum* region of its habitat. Within this region the tree is more or less independent of the nature of the soil; while away from it, it becomes more and more particular in its exigencies in regard to soil, until near the limits of its range it absolutely requires, to be able to struggle successfully with its rival, a soil possessing certain well-defined characters. If a forest is cleared or destroyed by fire and the area is left entirely to itself to re-clothe itself once more with forest, all those species of trees will reappear, within the optimum of which the locality in question is situated, while all the rest for which the soil is not extremely favourable, will not enter into the new crop at all. Thus, to quote an example, if white pine woods situated anywhere between the 43rd and 45th parallels of latitude, which form respectively the southern and northern limits of its optimum region, are cut or burnt down, new crops of white pine will take the place of the original crop; but if such woods are cleared outside those parallels, the new crop will consist of broad-leaved trees or of a pine of inferior size and quality. The life-history of the trees of the North American forests has not yet been sufficiently studied to enable me to furnish many such instances in proof of the position I have established; and it would lead me too far to quote instances in point taken from the forests of Europe and Japan.

The influence of woodland on the climate (*i.e.*, on temperature, rainfall, humidity of the air, and movements of the atmosphere), and on the level of the water in rivers and springs, has been abundantly studied, and is still being studied at numerous observatories in Europe and North America, and very much has already been written on the subject. Nevertheless, as one of the subjects of this paper is to indicate and explain the gradual but steady climatic changes that are coming over a country, the forests of which are slowly but surely disappearing, I must earnestly beg the honourable readers of this journal to pardon me if I repeat here what they know full well already, and regarding which they may read in a mass of special publications. I may, however, perhaps claim for myself a more popular treatment of the subject than they will find in those publications, for I think we need no scientific apparatus to show how quickly nature turns upon us when her laws have been violated. Of what use indeed are a mass of scientific figures and other details to the popular mind, which, as a rule, does not trouble itself about the mean temperature or mean rainfall during the several months of the year, which is usually quite satisfied to know that it is warm in summer, warmer in some years than in others,

that all winters are cold, but that some may be colder than others, and which, at the farthest, may perhaps interest itself in remembering the temperature and rain and snow-fall of exceptional years. Thus for the mass of the general public, amongst whom must be included the great majority of the forest-owning class of the United States, scientific researches, and the conclusions based thereupon, must remain more or less of a sealed book. What they require are broad facts, which bring home to them, much more quickly than the observations and learned disquisitions of the meteorologist, the influence of deforestation upon the climate. To such facts, therefore, will I strictly confine myself.

Going back to the question of frost-holes, I can adduce a very striking instance from Java. Many forests have been cleared away from the foot and gentle even slopes of the great volcanoes for the planting of cinchona. These lands are situated at an elevation of about 3,000 feet above sea-level, and belong to the cooler region of the tropics, of which tree-figs, laurels, palms, and bananas may at once be named as the most conspicuous floral representatives. Here it has been found that it does not require to clear more than 100 acres to bring in frosts which injure the cinchona plants, whereas in the surrounding area and everywhere before the invasion of man frost was entirely unknown below an elevation of 7,000 feet. I need scarcely add that the Dutch planters are now careful to avoid clearing as much as 100 acres in one place in low-lying lands, thus depending on the surrounding forest to keep frost out of their plantations and generally to level down all climatic extremes. It is one of the great functions of forests to level down all marked irregularities of temperature, relative humidity, and soil-moisture.

By removing the forest growth from the smallest surface of land, we increase the tendency in it to extremes of temperature and humidity, and bring it nearer to the condition of the treeless region, the prairie. The temperature will be higher than before in summer and lower in winter, and the soil will be now drier, now wetter than it was ever before. This change may, in a certain degree, be of no consequence as far as the interests of agriculture are concerned. Indeed, I do not hesitate to declare my belief that in the case of northern countries with a mixed forest of broad-leaved species and conifers of, and allied to, the fir tribe, the clearing of forests will improve the temperature conditions for agriculture, for the higher temperature in summer will be useful to a greater extent than the lower temperature in winter will be harmful ; there will be only one drawback, *viz.*, the increased risk from late and early frosts.

It is the general belief in Europe that the mean temperature of the year has not altered since observations have been recorded. We may grant that; but the mean annual temperature is no criterion at all for judging whether changes have or have not taken place in the peculiarities of the different seasons. Thus, if the heat in summer has increased to the same extent as the cold in winter, the mean will remain unaltered. For example, we all know what an immense difference there is between the climate of Baltimore and that of San Francisco, and yet the mean temperature of the year at both places is one and the same. But we have yet another reason for not relying too much on present meteorological records. It is only a few decades since observatories have begun to be established away from large agglomerations of population; observations taken in cities, and even small villages that are steadily extending and were surrounded by a broad strip of treeless land long before the commencement of observations, must surely be of no use whatsoever in determining whether any or what changes have been taking place in consequence of a decrease of woodland. A very slight further fall of temperature in the vicinity of the freezing point, in late spring or early autumn, or a momentary prolongation of an extreme temperature, may have fatal consequences in agriculture and forestry, and will yet certainly remain undetected by the meteorologist at the usual stations situated in the midst of habitations.

Another climatic factor unfavourably affected by the destruction of forests is relative humidity. The powerful influence exercised by the relative humidity of the air on forest vegetation has hitherto been entirely overlooked.* Although I had several times to refer to it in my first paper, I may repeat here that the result of a decrease in the wooded area is at once followed by diminished relative humidity, this effect being felt most during the hot season, when the largest amount of moisture is needed for the growth of high tree-vegetation. Observations to determine the mutual relation between forests and the relative humidity of the air have been instituted only very recently, and much, therefore, still remains to be found out. It has for a long time been accepted as an established fact that relative humidity and rainfall run concurrently; but no greater error than this assumption can be conceived. The prairie lying between the Rocky Mountains and the Missouri receives in May to August 130 mm. of rain, while the average relative

* It has certainly not been overlooked or even under-estimated in Fernandez's *Rough Notes for a Manual of Indian Sylviculture.*—[ED.]

humidity of the air during the same period is only 45 per cent.; on the other hand, in the prairie stretching along the coast of Southern California the corresponding figures for the same four months are respectively only 12 mm. and as much as 72 per cent. We may at once assume that no meteorological station situated in inhabited places far away from the forests can ever contribute any trustworthy data for the solution of the question before us. In Europe we have already our series of parallel stations, one set inside the forest, the other not far off in entirely open country.* The results furnished by these stations are most striking; the difference in the relative humidity of the air between the two sets of stations is from 5 to 10 per cent. in favour of the forests. In countries with a naturally moist atmosphere (above 70 per cent. during May to August), like Northern and Central Europe and the Atlantic coasts, a decrease of 5 to 10 per cent. in the relative humidity of the air will perhaps be harmless, as far at least as the growth of trees in height is concerned. But if we go westwards from the Atlantic into districts where the mean relative humidity sinks to 60 per cent. and lower, we need not be astonished if, after the devastation and disappearance of the forests with which those regions are now blessed, the climate frustrates all attempts to restore them by replanting, the seedlings being killed by drought and heat in summer and by dry cold in winter. It is not at all improbable that the prairie east of the Missouri River was once covered with forests, which, once destroyed, could not, unaided by man, return owing to the relative humidity having sunk at least 5 to 10 per cent. below the average figure at which forest-growth was formerly possible. It is, therefore, to be hoped that if ultimately the Americans determine to create a new forest there, it will be able to regenerate itself without extraneous help, and that if they begin by planting up in large close masses, they may thereby form centres of high relative humidity from which they could gradually work outwards till a line was reached beyond which every effort to raise trees must fail, *viz.*, nature's limit between prairie land on one side and forest land on the other.

Even in countries with a high relative humidity during winter and summer, the effect of a reduced relative humidity is clearly perceptible. Thus young seedlings planted out in the open, away

* The author is obviously not aware that we in India also have to a certain extent undertaken such observations, and would probably have still continued them but for the lamentable spirit at present militant in the Department, which *keeps science and scientific work entirely in the background.*—[Ed.]

from their natural protectors, the grown-up trees, will suffer from drought in summer, for rapidity of transpiration will be in proportion to the dryness of the air, with the consequent danger of the absorption of water by the roots being unable to keep pace with the loss through the leaves. Again, we notice that in winter, plants bathed in moist air, *i.e.*, surrounded and sheltered by a mass of other trees, can stand greater and more prolonged cold than those plants which are exposed to free insolation and a dry atmosphere. It would lead me beyond the limits of this paper were I to dwell any longer on matters that are familiar to every practical tree-planter.

Regarding the effect of a change in the relative humidity of the air on the composition of a forest, we know what to expect in an area that has been denuded of its original covering of trees. Besides light-seeded, broad-leaved species, like the birches, poplars, and alders, the inferior pines will also gain the predominance, and those species which require the highest degree of relative humidity, such as evergreens with their tender shoots and leaves, cedars, cypresses, and Sequoias, will refuse absolutely to thrive under the altered conditions, or will at least be reduced to a very small minority.

But little is known regarding the effect of forest denudation on the rainfall of the denuded area, although many instances have been adduced to show that the rainfall diminishes if the wood area diminishes, and increases if the latter also increases. All these various instances are, however, open to some other interpretation as well, and involve a good deal of guess-work, and none of them can stand the ordeal of a strictly scientific scrutiny. My own opinion inclines to the belief that the influence of forests on the rainfall is very slight, if any at all. Forests, no doubt, increase very considerably the relative humidity of the air, but this effect is confined only to the area actually under forest and the immediate vicinity, and is not felt at all even a short distance off.

The influence of forests upon the amount of moisture in the soil and upon the quantity of water in the rivers can hardly be exaggerated. Quite recently the trees of a forest have been described as so many effective pumps for drawing water out of the soil, so that a soil under forest should be drier than the soil of open treeless land. This description may be true for excessively dry places, in which the soil under trees will be deprived of its moisture to a greater depth than completely bare soil or soil that is under grass or agricultural crops. A slight shower of rain may saturate the surface soil on treeless land, without a drop reaching the

ground below well-canopied forest. But if we suppose a steady downpour lasting only 24 hours, then we shall never be wrong if we assume that the soil inside the forest will be wetter and moistened to a greater depth than the soil outside. And why will this be so? Because the rain water, running down the branches and thence down the stems and roots, will penetrate with ease into the lower layers of soil reached by those roots, while the portion which drops off the leaves and branches will be greedily sucked up by the moss and the decaying leaves and vegetable mould covering the surface, and will from thence gradually filter down to lower depths. Besides this, owing to the higher relative humidity, lower temperature, and stillness of the air inside the forest, the moisture under the forest will evaporate more slowly than that from the area outside. Thus in summer, after one or two bright days succeeding a good fall of rain, the open country may already be in need of more rain, while inside the forest the roads are still wet, the soil still moist, and the air still cool and humid. All these are facts which cannot have escaped the least observant, and they are the facts that demonstrate the influence of forests on soil moisture in a manner clear and intelligible to everybody.

To study this question a little further it is necessary to distinguish between countries with a continental and those with an insular climate, and between these and those possessing a combined continental and insular (*coast*) climate. In an insular climate the rainfall is more or less equally distributed over the twelve months of the year, and the forests upon the mountains are required merely to prevent the precipitated water from rushing down headlong into the valleys and thence into the sea, carrying away all the elements of fertility of the soil. As the distance from the sea increases, the rain falls less frequently during the dry season; so that when we come to continental climates, we find that the forests on the mountain ranges have, in addition to the function just described, to fulfil the extremely important rôle of storing up the excess of moisture precipitated during the days of heavy rain and giving it up slowly and gradually to the plains below during the dry season when they require it most. Thus, in continental climates, the mountain forests are of especial value to the country, which would be a desert without them.

At the same time we must bear in mind that there are forests and forests. The type of a forest fulfilling all its highest functions is the virgin forest, in which under the complete canopy of gigantic trees, a lower storey of trees and shrubs fills up all the intervals between the straight, clean, pillar-like trunks, and the soil, com-

posed of rich mould and mosses, gives nourishment and shelter to thousands of seedlings and saplings of various ages. Such a forest, to be maintained permanently in as favourable a condition as possible, requires to be treated in the most systematic and conservative manner, none of the sheltering trees being taken out until the seedlings below it are ready to fill up the gap made by its removal. On the other hand, a forest of scattered trees, with a heavy growth of grass between, which, along with the débris that fall annually from the trees, is consumed every year by fire, such a forest, *sit venia verbo,* is hardly better than no forest at all.

Inundations, the result of exceptionally prolonged and heavy showers, occur as well in unpopulated tracts covered with virgin forests as in settled populous districts, yet what an enormous difference in their mode of occurrence and consequences! In the interior of the northern Japanese island of YESO (popularly corrupted into YESSO), poor in population, but rich in virgin forests, inundations are a common event. The rivers rise 6 feet and even more above their normal level, but not as a thundering swirling mass of thick muddy water carrying away entire uprooted trees. The colour of the water hardly changes, and the only spoils of the forest it bears away on its bosom are old decayed branches broken away by the water from overhanging prostrate trees dead years ago; and when the river has subsided to its usual level, no traces of the flood are left behind, no silt, no stones, and boulders outside the river-bed, no mud on the trunks of standing trees to mark the height of the swollen waters. Need I now describe an inundation in populated districts in which the forests have undergone the usual devastation? Hardly; but what is that thing left after an inundation which we, in our indifference, contemptuously call *mud?* Ninety per cent. of it comes from the forests, from the fields. It is the very best portion of the soil, the fertility, the wealth of the country drained away, and lost to it for ever!

Inundations have always occurred, and will occur again and again; all that we can do is to provide against their disastrous consequences, to prevent them from becoming catastrophes. In doing this work two entirely different professions must co-operate, Forestry and Engineering. They must come in the order named, the Forester first, the Engineer afterwards.

The forests in the plains, on low hills, and on good soil are the first to be invaded by the farmer and have to retire before him. This cannot be helped. But if we stick to the forests on the lower hills and keep them in their active and benevolent condition as

long as possible, and preserve strictly all the forests covering the mountains and steep slopes against every kind of spoliation and destruction, against all attempts of the agriculturists, against partition into small holdings, we may still be able to prevent, when excessive rain falls, the surface drainage from the low country from receiving an accession, from the hills and mountains, of enormous bodies of water laden with sand and stones and boulders, and thus reduce the volume and violence of the flood-waters, and save, or at least mitigate, the danger of an inundation.

The question of preserving the forests in the mountains being satisfactorily settled, the result will be that the flood-line of the rivers will once for all cease to form a constantly ascending curve, as is unfortunately at present the case with every river of the United States; and then the Engineers may be called in to take measures to control the flood-waters of the country below by regulating the beds and banks of the streams.

One need not have taken up the newspapers and read of the calamitous floods of 1887 in the United States to satisfy oneself that these floods are only the forerunners of greater disasters still to come. I visited many districts in the Southern and Central States over which the floods had just passed. The standing trees were covered with mud up to a height of 15 feet, and scattered about everywhere lay hundreds of forest giants, not fallen from physical decay and more or less rotten, but still green, which had been uprooted in the full vigour of their growth; these were all from 200 to 300 years old. I also found along the banks of rivers many strips of forest that had been partially swept away, and the trees here were also 200 to 300 years old. The fact that the uprooted trees were all from 200 to 300 years old does not, as one may easily imagine, at all prove that the floods which overturned them were exceptional ones, such as would not recur again for a similar period of years. It rather proves that those disasters are the beginning of a new era arising out of a totally altered condition of things, which are steadily growing still worse owing to continued and even increasing human activity. This prospect is not a cheering one, but it is not entirely hopeless, and if I, as a well-wisher of the great American nation, were asked for advice, I could not do better than admonish them in these words:—"Cut your trees, but spare your forests."

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THE FIRE-FLY—A RONDEAU.

A fire-fly! a floating spark,
A diamond dancing in the dark,
  A roving star, now low, now high,
  Anon afar, anon anigh,
Then soaring like a joyous lark.

It seems to feel nor care nor cark,
But drifts above the watch-dog's bark,
  And wheresoe'er it wills, doth hie
                A fire-fly!

It gleams along the heated park;
It rests upon the dry leaves—hark!
  Is that a flame beyond, which I
  Among their tinder can espy?
Ah, no! It makes no scorching mark,
                A fire-fly!

ADVENA.

UP THE TONS.

LEAVING Thadiar on the morning of the 31st, I struck up the left bank of the Tons along a road which, until the main road to Ramasarai branched off it, some two or three miles higher up, was fairly good, but after that it became little better than a sheep track. Below me in the river bed were alders, willows, Celtis, *Cinnamomum Tamala*, and others of the Laurineæ ; but I looked in vain for the Engelhardtia, so common below Thadiar, until I had gone about four miles, when I saw a solitary specimen of it. Albizzias were very common, as was also the Rhus.

When once I had passed the boundary of the closed Government Forest, the chir forest, which clothed the slope above me, showed signs of the annual fires lighted by the graziers. In some places the trunks, half charred through, had been unable to withstand the wind and their large boles lay across the path. The burning of the grass seems to be carried out in a most systematic manner—not being burned all at once, but in patches in regular rotation.

Some of the chir trees here were, I think, the tallest I have seen, being *considerably* over 100 feet in height. A fallen one that I measured was 142 feet in the bole, and this, too, *in spite of the fact* that the point was burnt off. In some places the road,

or *path* rather, was lapped by the waters of the Tons; in others it rose some hundred feet above the river.

I camped that night on a triangular piece of ground which, although uncultivated, showed by a succession of terraces that it had once been tilled, probably before the Goorkha invasion, as chir trees as old as any in the surrounding forest covered it at intervals. On this piece of ground, which was nearly half a mile long by about 300 to 400 yards broad at the apex of the triangle, I found *Grewia vestita*, which, above Thadiar on the way to Deota a small tree, is here barely 18 inches high, with flowers and fruit on it. This was evidently owing to fires and grazing.

Noticing the hole made by a borer in a chir tree in front of my tent, I followed it up with my knife, and found that it did not penetrate further than the outer bark, and that the end of the hole was filled with grass seed, amongst which I failed to detect the insect that had made the hole.

Ficus Cunia with very large leaves was very common, as were also two or three other figs and several leguminous shrubs and small plants.

The waters of the Tons contain in suspension a large amount of mica and, where the floods had left *débris* on the bank, large quantities of it had been caught in the crevices of the soil, whilst on looking into the water minute particles of it could be seen flashing. The explanation of this I found afterwards when I went higher up, where all the streams tributary to the Tons had their beds in micacious rocks, which, where it was hollowed and smoothed by the action of the water, looked like enormous pieces of mother-of-pearl.

My next march was to Naintwar, to which place I had gone a little more than half way in my first day's march. The vegetation did not change, and the road was much the same as that of the previous day, save in one place, where it rose up the face of a cliff where some careful climbing was necessary. One thing worthy of notice at Naintwar was the difference in the colour of a stream which joined it from the north and that of the Tons itself. The clear blue of this stream, which seemed quite as large as the Tons, betokened its source to be a spring; but the snow-fed waters of the Tons quickly changed its colour into its own dirty grey.

At Naintwar I saw a piece of *dove-tailing* (if I may use the expression to designate a piece of work so unlike in all save the end obtained, what is understood by the original word), which I have never seen equalled.*

* *Dog-tailing* would not be an inappropriate term.—[Ed.]

I do not know what tools the villagers use; but the designs on some of the lintels of their houses and doors of temples show that they are no mean hands at carving after a quaint style of their own.

Next day's march took me to Sauré, some six good miles from Naintwar, and during this march the vegetation began to change considerably, probably owing to the fact that the road rose high above the river, which itself rose, or rather descended, from a good height, during the six miles. Hornbeam, poplar, spruce, blue pine, chestnut, walnut, and several other higher level trees, whilst at Sauré itself the ban oak mixed with the apricot.

On the way I passed a tree with a bole only 11 feet high, to which I was attracted by the large number of rings made by wood-peckers, and counted no less than sixty of them in the bole. Each hole was distinct, the bark of this tree evidently not splitting across so easily as that of the oak which opens out between the holes so as to form an unbroken ring.

At Sauré I was told that the road I had come was a *maidan* compared to the road I had to traverse! I should have been sorry to call it a *maidan* as compared to anything; but it certainly was not a bad road in comparison with that on which I found myself next day. In some places nothing but the roughened rock which composed the narrow ledges over which the road lay, prevented one from being dashed to pieces some hundred feet below. On the other side of a stream near Sauré I came across what was evidently a quarry for the slates which covered some of the houses in that village, and which they seem to pile on indiscriminately in a manner which speaks volumes for the strength of the structure underneath. The stream itself ran over a bed of the stones. I afterwards measured a piece quarried out higher up which was 4′ 9″ × 3′ × 2¾″. Many pieces of this size I should think would be enough to crush more substantial-looking houses in civilized places, and yet I saw even larger pieces on some of the houses. Shortly after leaving Sauré I came to a valley facing the north or right bank of the river. On its western side nothing but chir covered the slope, on the eastern side it was clothed with a dense growth of chestnuts, spruce, ban oak, and holly, with a thick undergrowth of ringals, raspberries, and Indigoferæ. Scattered here and there were the Rhus, brown birch, hornbeam, alder, and maple.

The next valley I came to was much the same with regard to vegetation, except that owing to a rocky soil the chir dotted both sides for some distance up before the other trees began. The road

here was very bad. In the next valley I came to, and where I camped that night, I thought I saw amongst other trees an ash. I could not get a specimen of it at that time, but on my return journey managed to do so.

My next day's march brought me to Datmir, which is at the top of a steep cliff rising from the river below. With the exception of the pull up this cliff the road was wonderfully good.

On the opposite side of the river the slope is clothed with deodar—the first place where I saw it in any quantity after leaving Deota—and on the top of the hill above the forest hut I also saw some of it as well as the first Bhojpatra I had seen. I did not go very close to the latter trees, and it was not till my next march (to Oosla) that I came within reach of a solitary specimen.

Round the forest hut at Datmir there were moru and kharshu trees, very old in appearance, some of them hollow, which had evidently been planted in rows. This circumstance I also noticed higher up near the village of Gangar, the rows varying from regularity so slightly as to preclude the possibility of their positions being accidental. There were box trees below the hut; but I saw none of any great size. Below the village is a large piece of ground under cultivation, and here I may mention that all up the valley the soil is wonderfully rich, even on the upper parts of the slopes. The chief products seemed to be dal, paddy, and chaulai. I found above the bungalow hazel and service trees, as well as the birdcherry so common at Deoban and Mundali.

My next march brought me to Oosla. On the way I passed through a dense forest of oaks, poplars, chestnut, maple, and brown birch with blue pine and spruce on the crests of the ridge, and alders along the water-courses.

It was not till next day that I came to pure forests of Bhojpatra on my way up from Oosla to Harkí Dún, my last camping place. There too I came across the shrub rhododendron with it's lovely mauve flowers, and a tree which reminded me so much of the mountain ash of Europe (the "rowan" of Scottish song and story) that I had little difficulty in identifying it with *Pyrus ursina* in Brandis's "Forest Flora." In a piece of marshy ground about four miles above Oosla I found the first horsetails I had seen in the Himalayas, but on my return journey I found them at Kathyan.

At Harkí Dún itself, which is a flat piece of ground at the junction of three valleys with streams, any one of which might with equal right lay claim to being the Tons, Bhojpatra andsome wind-

blown silver firs, were the only trees of any height. Rhododendrons (*campanulatum*) were the last shrubs of any size, along with stunted willow. Above them came *R. Anthopogon*, juniper, willows turned almost into creeping shrubs, and last of all nothing but small hardy plants and flowers, most of them our ordinary home wild and garden flowers, amongst them being vetches, everlastings, yellow pansies, and strawberry plants with flowers of a blood-red colour, and rhubarb, which made a very good pudding without requiring too much sugar.

One plant which I noticed in particular was one which no one could help observing from the darkness of its maroon or claret flowers almost approaching blackness. It was one of the *Leguminosæ*, but its name I have not been able to ascertain.

It was not until on my way down that I found, about a mile below Harkí Dún, a hawthorn tree, the first and only one I saw.

Up the three valleys I have mentioned above I went on three successive days. All three, except that the one furthest south, had more stunted vegetation at the mouth of it than the others, were much the same in appearance—a plain covered with flowers up to a certain point, then boulders and fragments of broken rock, then snow, its surface yellow with dust, and after that snow in all its purity covering the sides of the slopes, and blocking up in dense masses some of the smaller hollows.

The valley to the north was the prettiest of the three, the stream which flowed down it broadening into small lakelets in two places, and its source, which I reached after four hours' steady climbing over boulders and snow drifts, I found to be another of these lakelets, which was, no doubt, increased by the melting snow, but must have been fed by a spring somewhere, although I could not see any signs of one. My reason for supposing that there was a spring was the fact that its upper side contained open flowing water, whilst its lower side entered and disappeared below a large drift of snow, whence it emerged some fifty yards lower down by a low-roofed cave, with frozen walls and roof supported on pillars of ice and festooned with icicles.

This I took to be about six to seven miles from Harkí Dún, whilst, as there was no snow there and here it was piled up, with its melted faces showing regular strata, I fancy I was some thousands of feet above my camp. I was shown a pass over this snow, by which I could have looked over the head of the valley, but it was too late to think of it, and it was all I could do, as it was, to get back before darkness set in.

The next valley I went up was the one to the southward. One thing about this one, as I observed above, was the fact that vegetation reached further up it; but this was not, I think, owing to its lying north and south, but to a curious fact which I shall endeavour to describe.

A little way above where my camp was pitched you crossed, by a rough semi-natural bridge, the streams from the north and north-east, and climbing about 30 feet higher up, you found yourself overlooking a large plain with a stream running through it several hundred feet below you, although the water behind you, and which is joined lower down by this stream, was only a few feet below you. In fact it is nothing but a ridge of impermeable rock, which prevents the two streams from the north and north-east from joining the third long ere they do so.

At a point which I guessed to be about eight miles from camp, the head of this valley took a bend to the northwards, and joined another leading down the other side, where I did not attempt to follow it. At the head of it there were the same snow-clad cliffs and stratified drifts in the hollows, which I noticed in the other valley. The stream which flowed through it kept losing itself under masses of boulders and reappearing again in the most unexpected places.

The walking over these boulders constituted the worst part of the walk up and down. It is tiring work walking up one side of a large boulder and down the other, or stepping from one to another without knowing when they are not going to turn under your foot. Imagine yourself walking over the ruins of stone-built houses for a mile or so and you will have some idea of it. To what depth this layer of stones reached I cannot say, but I certainly saw 12 or 15 feet down through it in places, and still I could not see the earth below. Sometimes these rocks were piled into little hills far above the level of the surrounding boulders; but whether this was owing to glaciers or to the simple falling of rocks from the cliffs above, I cannot say. Their toughness and jagged edges threw doubts on the former theory, whilst their distance from the bases of the cliffs belied the latter.

The third valley, the one to the south-east, after running for about a mile in a south-easterly direction, turned round towards the south. The vegetation below my camp was much the same along the river bank as that at Datmir. *Pyrus ursina* I found a solitary specimen of, but a little way above the river bank Bhojpatra had the ground all to itself.

I had intended to return by Thittakumta and Ramasarai, but

could not owing to unavoidable circumstances, so that my return journey was almost over the same ground as I covered on my way up, elms, hawthorn, and ash being the only trees added to my notes, and so ended one of the pleasantest trips I have ever enjoyed, the weather all the time being exceptionally good, and the cold, even at nights, being only slightly felt.

W. F.

A MORNING ON A KONKAN HILL.

A BROILING morning in the broiling month of May, the time between seven and eight. The sun is beating down mercilessly, and the hill that I am climbing is dreadfully steep and slippery. The grass has all got burnt up, and affords almost as treacherous foothold, at the angle at which it presents itself, as so much ice would. Steadily I mount, wishing fervently for a breath of wind to fan my perspiring brows, for, as I press on upwards, I "lard the lean earth" generously! Presently a sound not often heard in the Konkan jungles—at least in those in the neighbourhood of the sea—is heard, the cough, namely, of an irate or startled monkey, the well-known black-visaged *langúr*. Looking about, I soon spy one (a female evidently, as she carries a young one in her arms), seated on the top of a bare teak tree. She is in a state of violent excitement, and is swearing volubly, not, however, at me, but at something still concealed from my view. I throw myself (glad of any excuse for a halt!) on the ground and watch for the sequel. Shortly a village dog comes up, and then another, and another. My friend, the monkey, is evidently the object of their attentions, for, on reaching the tree on which she is seated, they pull up and surround it. Dark objects are visible here and there in the distance: these are "Khatkaries," a semi-wild tribe who inhabit the Konkan hills. They are the masters of the dogs, and monkeys, in various shapes, would apparently be found in their list of delicacies for the table. As the wild men approach, the monkey, thinking "discretion the better part of valour," betakes herself once more to flight. Carrying her young one with her and leaping from tree to tree, she rapidly ascends the hill, not touching the ground, and "the merry chase goes heedlessly sweeping by" within a few yards of me. I have had a first-rate view of the hunt, for I have gained a point on the hill above the line taken by the harassed monkey and her unrelenting pursuers, and have therefore seen everything splendidly. The silence in which the chase is conducted is most striking, both dogs

and men are mute, and the quarry also has relapsed into silence since resuming active flight. I had some Khatkaries with me, and asked them questions about the whole thing. They told me that a dog, single-handed, was no match for an ordinary-sized *langúr*, who could and would tear one to pieces very shortly, had the dog the temerity to attack it unaided. Three or four dogs were needed to pull down one *langúr*, unless of course a man was near enough to come in to aid at once. Monkeys are very greedily eaten by the Khatkaries. I heard afterwards (when returning from my inspection) that the baby-monkey had been killed, while the elder one had made good its escape—rather to my surprise, I must confess, as I did not think that the mother would have abandoned her young one under any stress of circumstances.

But my adventures were not yet at an end. Before leaving the hill, I heard again a curious sound. What is it? With ears pricked up and every nerve on the stretch I listen! No doubt of it; some one sawing up timber! "Rather cool!" I mutter to myself, and away in the direction of the noise we go, stalking as silently as the dry teak leaves will permit. My associates for the time being, the Khatkaries, hang back. "A fellow-feeling makes us wondrous kind," and they do not relish the idea of assisting at the probable capture of a fellow-tribesman. On we go cautiously, the excitement is growing intense, when the Khatkaries all at once begin pushing to the front quite eagerly. Anxious to know the reason of this sudden change, I enquire and am told, in reply to my queries, that the sound we hear has nothing whatever to do with wood; it is caused by a party of Khatkari women hunting for land crabs (in Marathi *kakeda*). Sure enough we presently espy the tinted Dianas, and, after a little parleying, the results of the chase (some two dozen crabs) become our property, their ultimate destination being the Natural History Society's Museum in Bombay. These crabs apparently lie dormant during the dry months under large stones and similar places of refuge, emerging only when the rains set in again. The wild people rub such large stones as seem likely to be places of retreat for their prey with other stones. The crabs mistake the sound for thunder! (no joke intended, for I got the explanation at first hand, on the spot, from the Khatkaries themselves). Under the belief that "Here are the rains again, hurrah!" they come out, are caught, and are in due time popped into the wild man's cooking pot, and thus fulfil one of the functions at all events for which they were included in Dame Nature's scheme. And so home.

G. K. B.

BREAD-MAKING.

In your endeavours to infuse into our minds the principles of scientific forestry you have hitherto overlooked a very important essential to success, namely, the necessity for disseminating, at the same time, useful hints in that special branch of knowledge by the aid of which we are enabled to maintain, in an efficient condition, the corporal foundation upon which depends the supply of the store of energy so largely drawn upon—by the exercise of our mental faculties—in our efforts to grasp and retain the great principles you teach.

I refer to corporal, as an aid to the capability of absorption of intellectual, sustenance.

Pabulum for the mind, of which you provide an inexhaustible supply, is, no doubt, very necessary; but this usually takes the form of very hard knotty points not easy of digestion: it may not, therefore be out of place here to offer (you having omitted to do so) to contribute towards the means by which the foresterial mind may be maintained in a fit state to assimilate the kind of food, often of foreign importation, which you generally provide for its nutrition.

Apart from this consideration, I feel sure that the Forest Officer, who is situated without the pale of civilization, will be most grateful for anything that will add to his home comforts, or that will tend to mitigate the severity of the "struggle for existence," which he continually maintains during the period of his sojourn in camp.

With these few prefatory remarks, I do not think I need offer any apology for seeking—even though it make your editorial hair stand on end—to desecrate the pages of our scientific journal by the introduction of so gross a subject as that of *Bread-making*. The subject, indeed, is an important one from every point of view.

For many years I have been the victim of dyspepsia, resulting from the consumption in large quantities (for I have a good appetite) of leathery chupatties, soda scones, woodeny biscuits, *et hoc genus omne*, all my efforts to procure a wholesome bread having proved abortive; but at last I have lighted upon a drunken cook (blessings never come singly) whose sole accomplishment (if his powers of imbibition be excepted) lies in the art of bread-making. At first he was not very successful, and his recipè naturally was a little "mixed," but by dint of perseverance I have succeeded in reducing it to something like intelligible order; and in the exuberance of my gratitude for having obtained a good, wholesome, palatable bread, I now hasten to impart the secret of its composi-

tion to my fellow-sufferers. Being ambitious I have endeavoured to word the recipè in the orthodox cookery-book style.

Recipè for making Bread.

To prepare the Yeast.

Take of

Sugar,	...	...	1 teaspoonful.
Flour,	...	...	1 dessertspoonful.
Hops,	...	...	1 teaspoonful.

Put the flour and sugar into a bottle; boil the hops in a breakfastcupful of water until the liquor is reduced to a quarter of a cup; allow it to stand till lukewarm; then strain and pour into the bottle over the flour and sugar. Shake the bottle well, cork and tie down. Put in a warm place for 48 hours, after which it will be ready for use. Call this (A).

When the above is ready, take of

Flour,	...	...	1 tablespoonful.
Hops,	...	...	1 teaspoonful.

Prepare the hot liquor as before and pour into a clean bottle over the flour; add to this a tablespoonful of (A); shake the bottle well; cork and tie down securely. This will be ready for use on the following day. Call it (B). The remainder of (A) may be thrown away.

You may now proceed to make your bread as follows:—Take of

Flour,	...	...	1 lb.
Salt,	...	...	1 level saltspoonful.
Sugar,	...	...	1 teaspoonful.
(B),	...	...	1 tablespoonful (in cold weather; half when the weather is warm).

Mix thoroughly with a sufficient quantity of lukewarm water and knead well; place it to rise within the influence of the heat of a fire (when the weather is cold), and when ready divide into two, put into shapes, and bake.

A fresh supply of (B) must be prepared *every day* (to be used in making the bread on the *following* day), with this difference only, that instead of the tablespoonful of (A) used in making the *first* supply, an equal quantity of (B) is to be substituted.

With ordinary ata this makes a most excellent brown bread, far superior to the stuff usually provided by the station baker. I hope that all who read and honestly try this recipè will, as in duty bound, be truly grateful to

1st September, 1890. A DRUNKEN COOK.

III Official Paper.

THE CULTIVATION OF ORANGES, LEMONS, AND FIGS IN INDIA.

A.—Oranges.

The Santara.—The best orange grown for profit in India is the "cintra," a name commonly assumed to be derived from the Portuguese town, but lately declared to be a corruption of a Sanskrit word, which should be pronounced "suntura."

The tree which bears this fruit is of upright habit, in this country rarely exceeding 12 feet in height and 8 feet in expansion of branches. The leaves measure 1½ by ¾ inches and 2½ by 1¼ inches—the winged joint being very slightly developed, the flowers are ¾ inch in diameter, have 5 petals, 20 to 24 stamens, and 9 to 10 carpels. The fruit is found of two varieties, one having the skin remarkably loose and evidently overgrown beyond the pulp, and the other having a smooth tight-fitting skin. As grown at Nagpore, this has been declared, by people who have travelled much, to be the finest orange known in the world. The inner skin is very delicate, and the liths (carpels) so slightly cohering that it is easy to break up for the eating. Well-grown specimens have only two or three seeds. The flavour of the two varieties is equal, if grown under similar conditions; but the loose-skinned variety has an imposing appearance, and is rather more easily peeled, consequently it is the market favourite. Ordinary market specimens of the fruit average 8 ounces in weight, but 10-ounce specimens are common.

The Mozambique Orange.—The Mozambique orange *tree* is evidently a distirct species, of strong growing habit, producing an irregularly globular head and bearing leaves measuring 2¼ by 1½ to 5½ by ¾ inches, entire or very slighty and irregularly serrate, the apex being pointed or cut out. The leaf-stalk is ¾-inch, the wings on one of the joints attaining ¼-inch in width, often less and sometimes wanting. The flowers are 1¼ inches in diameter, have 5 slightly oblique petals, which are glandular on the outside and 20 to 24 stamens. Average specimens of the fruit grown

in India weigh 8 ounces, but specimens of 13 ounces in weight imported from Mozambique are common. In shape it is globular, slightly compressed vertically; the skin is medium in thickness, tight-fitting, and marked by numerous small vertical furrows and a circular smooth mark, about 1 inch in diameter, on the upper end. The pulp is usually pale yellow, but when dead ripe becomes of a brownish yellow, that may be called the medium tint of orange pulp. In flavour it is sweet, but without the piquancy of the best varieties; the inner skin (endocarp) is tough, so that this orange can only be sucked. They keep in good condition about two months.

Ladoo Orange of the Deccan.—The tree which bears this variety produces long branches apt to spread out considerably as the tree attains size. The leaves are from 1½ by ¾ to 2½ by 1¼ inches, with the winged joint of the stalk very slightly developed. The open flowers are ¾-inch in diameter, of 5 petals, 20 to 24 stamens, and 9 to 10 carpels. The fruit attains 8 ounces in weight, is in shape a much depressed globe with a distinct nipple at the stalk, and within the skin on the upper end generally has an extra orange, about ¾-inch in diameter, with 5 to 7 liths (carpels). The skin is of a dusky yellow colour, moderately rough and loose, and of medium thickness; the inner skin (endocarp) very thin and enclosing juicy sweet pulp of piquant flavour and medium tint of colour. This is a fine orange, but it does not bring a high price, on account of its indifferent appearance.

Lall Ladoo of the Deccan.—I have identified this orange with the Mandarine orange of books. The tree resembles the "*Ladoo*" in habit, leaves and flowers, and shape of fruit, but the skin of the fruit is a deep orange colour, smooth, loose, enclosing 11 liths, having a stronger inner skin than "*Ladoo*" and 20 seeds—a very handsome, attractive fruit.

The Cowla.—A small-sized, indifferent orange, which becomes yellow on the tree before it is sweet.

The Sylhet Orange.—This is common in the Calcutta market, and is grown in the country whose name it bears. It averages 5 ounces, has a tight thin skin and good flavour. The Malta and St. Michael's oranges have been introduced, but are not making progress wherever it is possible to grow the "Cintra."

Cultivation of the Santara at Nagpore, C. P.—The finest oranges in India and, in the opinion of some, in the world, are grown near Nagpore, which lies in North Latitude 21° 9′ and East Longitude 79° 11′, about 350 miles from the sea, and at an altitude of 1,025 feet above mean sea level.

The orchards are fully exposed to the sun and on level ground, having a dark-coloured stiff loamy soil not less than 3 feet in depth, and overlying a sub-soil of open nodular limestone. The soil is formed of disintegrated basalt.

The climate may be described as comparatively hot and moist from June to September inclusive, cool and dry from October to February, hot and dry from March to May. It must be noted that the temperature is taken under standard meteorological arrangements, which require the thermometer to be shaded from direct sunshine and from radiation at night. The mean insolation or excess of temperature obtained by exposing the thermometer to the sun as compared with the shade temperature is 59·8, and the nocturnal radiation, or decrease from the shade temperature when the thermometer is exposed to the sky, varies from 12·8 in January to 2·7 in July.

There are two distinct seasons in which the trees will flower and ripen fruit; and to obtain high class fruit, the cultivator must elect which season to work, as the trees will not bear properly at both seasons. The finest fruit is obtained from flowers that open in June-July, and is on the market from February to May.

The second flowering is in February-March; this ripens fruit from December to February.

The trees are kept dry during May or December, according to the season at which fruit is wanted; at other seasons irrigation is carried on sufficient to provide, with the rainfall, at least 4 inches of water over the entire surface per month. The irrigation water is drawn from wells about 30 feet in depth, by means of a leathern bucket containing about 25 gallons, which is drawn up by bullocks that go down an incline, pulling a rope which passes over a simple pulley. The cost of drawing water 30 feet is about 1 anna (at par nearly 3 cents.) per 1,000 gallons.

The water is turned into small surface-channels made by drawing up a pair of parallel ridges, 18 inches apart and 9 inches high, and given a slope of 1 per 1,000. One channel serves two lines of trees, and from it the water is passed into sunk beds round the stem of the tree, extending as far as the sweep of the branches. About 1 to 2 inches in depth is given once in 10 days. The soil is kept moist from the flowering till the fruit is all gathered.

The soil is kept clean and open on the surface by ploughing 4 inches deep thrice yearly. For the crop that ripens during February, March, and April, water is withheld, the soil is opened up during April-May, and the roots exposed during 15 days, so that the trees get a check sufficient to cause the greater part of the leaves

to fall. Then 100 lbs. weight per tree of old, moist cow-dung of a reddish brown colour is mixed with the soil, and the roots covered up and watered heavily if rain does not fall soon. This causes the trees to burst into bloom and fresh growth ; thereafter the soil is kept moist till the fruit is gathered.

The same operation carried out in December brings ripe fruit during December, January, and February.

Suckers from below the graft must be cleared out, and weakly or decayed branches only cut out. Excessive pruning must be avoided, as it tends to cause the trees to "run to wood," and prevents flowering.

Fruit continues to attain full development during a month on each "break" of trees that has been started into growth together, and it is picked over at intervals of a few days.

A faint trace of yellow in the skin of the fruit indicates maturity. When fresh from the tree this fruit has a delightful rich piquancy of flavour that is to a great extent lost by being packed up for a few weeks, but the fruit remains in good condition two months, if not closely packed. No special curing is given, unless the fruit has been gathered unripe ; in that case close packing, with soft hay in a box is sufficient. Such fruit is always inferior. In packing, 30 to 40 lbs. weight of oranges are placed in very slim baskets without any packing, and the lid tied down. None of the fruit is shipped as merchandise.

The trees are planted about 12 feet apart each way.

Seeds of *Citrus medica*, a large coarse citron of vigorous habit, are sown, and when the stocks are two or three years old, budding is effected. The form of budding used is peculiar, and I think advantageous in unskilled hands. No transverse cut is made in the bark ; having made the vertical cut, the operator bends the stems gently towards the side having the cut. This causes the cut to gape open, and the bud having been inserted, the stock is released, and springs up, closing in the shield of the bud. A bandage consisting of a strip of banana stem is then applied. I think the want of the cross cut saves the gumming, that ensues if the cut is made too deep. Occasionally the sweet lime, *Citrus limetta*, is used as a stock, and it is believed by some to ensure more sweetness in the fruit. I have not proved this, and do not think it can affect the degree of sweetness.

The best varieties are invariably budded. Seedlings take so long to bear fruit as to be useless in practical fruit-growing.

The orchards generally measure from 5 to 10 acres.

The trees begin to bear at 3 years from the bud, carry the heavi-

est crops between the 6th and 10th year, and after the 15th year rapidly decay.

An important insect enemy is the caterpillar of *Erythro papilio*, which eats up the foliage during June-July. Hand-picking is the chief remedy employed. An undetermined wood-boring insect attacks the trees as soon as decay sets in, and is commonly supposed to be a cause of decay. I think it is rather a sign of decay. Hot tar poured into its holes kills the insect, but does not arrest decay when far advanced. If there is any sound wood left, it is advisable to cut back severely, but trees so treated do not fruit for two or three years after the operation.

It is doubtful whether any insects are beneficial, but the entomology of Indian fruit culture is as yet but fragmentary.

Lemons.—Lemons are not exported. The large Citron can be produced in quantity very cheaply, but, except by dyers for the acid, it is little used, and brings a very low price.

Note.—The latest edition of my own book is the fullest account available,* but that is superseded by this report, as far as oranges and lemons are concerned.

B.—Figs.

Figs are not dried in India to any considerable extent, as the local consumption absorbs the supply.

Varieties of figs are not named in India except with the name of the village they come from, which is not distinctive. The variety widely cultivated in the Deccan is inverted-conical, green at the stalk, and gradually deepening to brown at the broad end; it has alternating stripes of green and brown, and good examples weigh ¼ lb.

Village of Khed Shivapore, 14 miles south of Poona, which city stands in North Latitude 18° 28′, East Longitude 74° 10′, altitude of Khed Shivapore about 2,200 feet. Exposure to sun, full. Land of the orchards is nearly level, but the orchards are on the slope of a range of hills of 3,500 feet altitude. The altitude of the plantation is 2,200 feet.

The soil is a poor calcareous loam, sub-soil being marl, a mixture of lime and clay on disintegrated trap.

The temperature averages about 75 degrees; minimum, 48 degrees; maximum, 100 degrees. The village is shut in on the north, east, and west by hills, which keep out hot winds.

The rainfall is about 50 inches, falling chiefly from June to

* Since this was written, Dr. Bonavia's "Cultivated Oranges and Lemons, &c., of India and Ceylon" has been published.

October. The falling of rain sets the trees growing, and determines the ripening of fruit.

The irrigation is from wells, 2 inches per month from end of October till the fruit is ripe. Cultivators do not usually make special efforts to get sweet fruit, but the small quantity of water given has that effect.

The mode of cultivation is ploughing 4 inches or hoeing at end of rainy season.

The fertilizers used are village sweepings, 50 lbs., well decayed, per tree, applied after the crop is gathered.

After the tree has been caused to send up 5—7 branches from near the base by shortening the shoots sent out by the cutting, little, if any, pruning is given ; broken branches are cut out, and such as have gone higher than a man can reach with the hand, have the points taken off, and are cut out to the base after all the fruit has been gathered ; but the less pruning that is necessary, the better.

A few are grown as standards, the branches proceeding from the central stem at a height of 6 feet and spreading out horizontally.

The picking is done when the fruit is full grown, and shows a slight yellowing of the stalk. Early in the morning is preferred, because, if protected from the sun, fruit so picked retains a delicious coolness. For local use, each fig is wrapped up in a leaf when it has attained this stage, to protect it from birds, and is left on the tree a week longer. This improves the quality greatly, but carriage to a distance is impracticable in such a case. No boxing or curing is done in India.

The trees are planted 10 to 12 feet apart.

Propagation is effected by means of cuttings of 1-year-old wood planted in a shady bed in February.

The orchards are about 2 to 3 acres in extent only, because the situation on a hill slope does not admit of large level spaces fit for irrigation.

The trees live 15 years ; are fruitful during about 12.

The red spider is a serious enemy. No futile attempts are made against it by the cultivators; they think sacrifices to idols effectual.

The subject of fig cultivation has not yet been worked out.

I have never sent cuttings of figs so far as America, but I think that if cut in February, packed in moist sand in a tin box, and sent by post a few would survive the journey.

The latest edition of my book "Gardening in India" gives the fullest account available, but it is not as full regarding figs as this report.

Poona, 1890. G. M. WOODROW.

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NOTES ON THE UTILIZATION OF FORESTS.

(Continued from page 48.)

2.—*Emplacement of the kiln.*

THE site selected should be sheltered, even, and level, and it should be close to abundant water and to the wood to be carbonized. If the quantity of wood is large, there ought to be room enough for several kilns, as the same party of burners can just as easily manage several kilns as a single one. The nature of the soil is also of considerable importance. A soil that is too free and porous would allow too strong an upward draught of air to pass through it into the burning wood above, while a too stiff soil would, on the contrary, cause the kiln to burn too slowly. A loamy sand is the best, as, besides possessing average stiffness, it absorbs at once the condensed vapours given off by the wood, which in a stiff soil would clog the surface and interfere with the carbonization. It is absolutely necessary that the soil of the entire site should be uniform, otherwise the kiln would burn more rapidly at some points than at others, the result being unequal subsidence and consequent extensive and frequent breakages, and hence unequal carbonization and unprofitable waste of wood.

If a new site is used, it must be very carefully prepared. Such preparation will consist in (1) clearing away all vegetation by the roots; (2) removing all stones, for carbonization will be unnecessarily slow over boulders and injuriously quick over smaller elements; (3) raising the site about 8 to 12 inches in the middle and sloping it down outwards in every direction, so as to allow the liquid products of the kiln, which cannot be absorbed into the soil, to run out

freely. The soil should then be allowed to settle for two or three months until it becomes close enough. If it is damp, it should, just before it is used, be warmed up and dried by burning over it a thick layer of dry twigs and leaves.

An old site is preferable to one that is perfectly new; in the former the soil has already undergone the necessary preliminary preparation, and it is a matter of experience that in a fresh-made site the yield of charcoal is from 10 to 17, and sometimes even 25 per cent. smaller. But of course a site on which a kiln has just been burnt cannot be used again until the moisture that it has absorbed from the kiln has completely dried up.

Even before using an old site, the surface must be carefully re-dressed and the numerous pieces of charcoal, left in it from the previous burning, broken up small and mixed up intimately with the soil.

3.—*Building up of the kiln.*

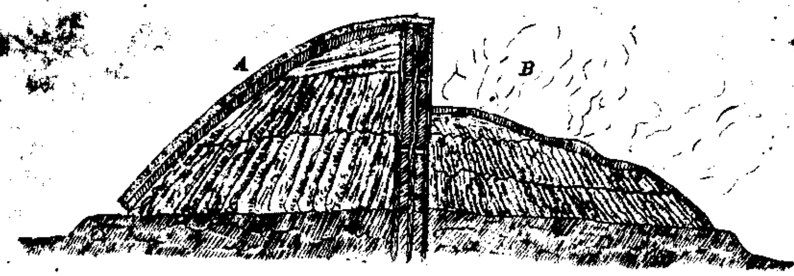
In building up a kiln, the pieces of wood may (*a*) be all laid horizontally, or (*b*) horizontally only in the topmost tier with the rest set up more or less vertically. In the first case the system of piling up the wood is the same as that followed in constructing the paraboloidal pit-kiln, in the Article on which it will be found described. For this reason, and also because a kiln so formed is much more difficult to build and is more liable to unequal subsidence and breakages (these drawbacks increasing with its size), nothing further will be said regarding them in this Article.

First of all, the chimney or flue through which the kiln is fired has to be formed. For this purpose three straight upright posts, of the same height as the future kiln, should be firmly fixed in the centre of the site, about a foot apart from each other, and bound round with wattling or strands of twisted grass. As the kiln rises, readily ignitible chips of wood or half-burnt fragments obtained from a previous burning are loosely thrown into the flue until it is nearly full. According as the wood in the chimney is to be fired from above or from below, the largest fragments are placed at the bottom and the smallest and most combustible at the top, and *vice versâ*. In either contingency, if the soil is damp, a small board must be placed over the ground under the chips, to prevent the fire from being smothered by the steam rising up from the ground.

The next step is to pile up the wood to be carbonized. To ensure a circular section to the kiln, the base should be accurately pegged out. The wood is arranged in three or more tiers, according to the

size of the kiln. *Fig.* 66 A shows the disposition of the wood in

Fig. 66.



Paraboloidal over-ground kiln with upright stacking.
A.—Before firing. B.—Carbonization complete.

a kiln composed of three tiers. The upright pieces should rest on their thick end, so that they may incline more and more towards the chimney the further away they are set up from it; there is no other way of giving to the sides of the kiln the slope necessary for their stability, which slope should nowhere exceed 65°. It is evident that all the upright pieces in the lower tiers should be of equal length in one and the same tier. Those in the topmost tier, being laid horizontally, must, on the other hand, be necessarily of different lengths to admit of being closely packed together and to enable the apex of the kiln to be properly rounded off. It is not necessary that the whole of a tier should be completed before the next one is begun; indeed, it is always more convenient to commence building up this latter when the other has been about half completed. In the topmost tier, as in all the rest, the laying of the pieces should progress from the chimney outwards, and great care must be taken to secure an even paraboloidal outline without placing any piece on the outside in such a way that it must fall off when the kiln begins to subside with the progress of the carbonization. The packing should everywhere be as close as possible, for the volume of every piece must diminish considerably as it becomes carbonized, thus causing all originally empty spaces to grow larger and thereby diminishing the stability of the kiln. As a further precaution, the numerous intervals that must remain even after the most careful packing should be filled up tight with thin pieces and chips, preferably of completely dry or, better still, if at hand, of half-carbonized wood.

If the kiln is to be fired from below, a narrow passage, extending as far as the chimney, should be left open along the ground,

whereby the combustible material at the bottom of the chimney may be reached when the kiln is ready to be lighted. The passage is easily made by laying a straight pole on the ground and arranging the billets on each side of it in the way that a house is built up with cards, the pole being finally withdrawn.

The wood placed immediately against the chimney should consist of thin split pieces, dry enough to take fire readily. The best material to use, if obtainable, is the half-charred wood from a previously-burnt kiln. The packing near the chimney should be specially close, all interstices being filled up with chips and shavings.

As split wood takes fire most readily on the split side, such wood should be placed with this side facing the chimney or downwards, as the case may be. This position of the pieces also helps the wood to be packed with greater ease and closer together.

The thickest pieces should be placed where the heat will be strongest and steadiest, that is to say, about midway between the chimney and the periphery.

4.—*Covering the kiln.*

In order to prevent the unchecked entry of air amongst the wood and to regulate the indraught during the carbonization, the covering put over the kiln should be such that, while it is easy to put on and take off or increase and diminish in thickness at any point, it should subside evenly as the kiln subsides, without falling away or opening out in rents and fissures. Experience has shown that it should always consist of two parts, (1) an inner layer composed of moss, sods of turf, green weeds, leafy twigs or green grass, and (2) an outer one of wet earth plastered or thrown over the first.

The inner covering must obviously be formed with some green, yielding fibrous material that does not take fire too easily and is at the same time able to hold together, however much the kiln may subside. Moss and close turf are the best for the purpose, and grass the worst. When grass is used, it ought to be short, soft, and fine. Whatever the material is, it should be the same throughout, otherwise the covering will both lie and subside unevenly.

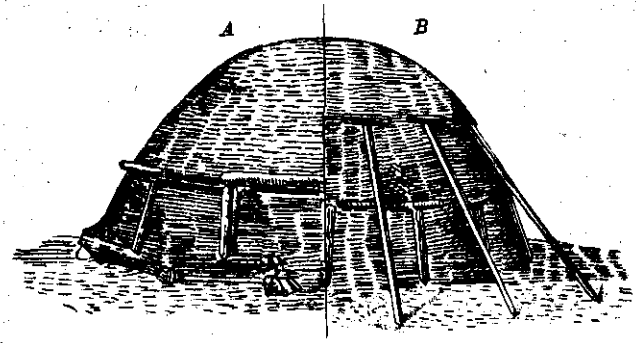
For the outer covering we require a soft earth which will not form a too stiff and impermeable mass when moistened, will not harden and become full of cracks with the great internal heat of the kiln, and will not conduct heat too rapidly, but which will at the same time not lie so loosely as to fall away too easily and not be so porous as to be too freely permeable to air. Hence the best natural

material is loam containing a large proportion of vegetable remains, and the best material of all is the earth obtained from an old kiln with its large admixture of ashes and fine cinders.

The first covering should be laid on beginning from the top, so that every portion of it may be supported and prevented from slipping downwards by the overlapping portion immediately below. It should be thick enough to prevent the earth of the outer covering from falling through amongst the wood and thus retarding and even preventing carbonization. In order to obtain a good indraught of air while the kiln is taking fire, the covering should not at first be put on too thick near the ground, and may even be left open at a few points there, such openings being stopped only when the carbonization is in full progress. Similarly, the vent of the chimney should also be left open until then.

The earth for the second covering should be freed of stones and other large fragments, which would destroy its even texture and let in unequal draughts of air. All clods should be broken up fine and the whole mass of material thoroughly well worked up until it is of uniform texture throughout. For the top of the kiln and those portions which have a gentle slope, the earth need only be moistened just sufficiently to keep the particles together, and then it is best thrown on with a shovel, so that it may get evenly distributed and ultimately rest safely at the proper angle of repose. For the steep portions, especially when grass is used inside, the earth should be made into a sort of thick mud and plastered over the grass. To prevent the earth from slipping off the steeper portions, it has to be propped up, especially near the ground. Two simple and effective modes of propping are shown in *Fig.* 67.

Fig. 67.



Mode of propping up covering of kiln. Different styles shown at A and B.

5.—*Firing of the kiln.*

If the kiln is to be fired from below, a torch is formed at the end of a long pole with grass and some highly inflammable chips of wood. The lighted torch is inserted into the open passage left along the ground and pushed home against the bottom of the chimney, the pole being at once withdrawn. The draught along the ground and up the chimney carries the fire into the latter, from which then as centre it is able to spread outwards amongst the wood to be carbonized. The chips and other small fragments of wood placed in the chimney are quickly consumed; as they subside, fresh pieces must hence be gradually stoked in from the top. Ultimately, when the fire has become established and has begun to spread outside the chimney, this latter is filled up tight to the top with short billets of wood. If this last operation is not properly done, the chimney will soon become empty and cause the wood from the sides to fall in, thus leading to unequal subsidence and to the breaking up of the kiln. After the chimney is full, and even earlier if the wood is very dry or a strong wind is blowing, the tunnel along the ground is filled up with short straight billets well packed together. When the combustion inside the kiln is in full progress, the covering is completed over the open extremities of the chimney and tunnel. It requires some experience and judgment to close these openings at the proper time.

If the firing is to take place from above, a dishful of live coal is dropped into the chimney and the fire worked into the chips below with a thin bar of iron or even a green sapling. The fire is stoked from time to time with small pieces of dry wood, and, finally, when the wood in the chimney is in full combustion and the fire has reached the bottom, the chimney is filled up and closed in the same manner as in the method of firing from below, already described.

Firing from below is always troublesome, and the necessity of leaving a passage open along the ground breaks up the regularity of the stacking and renders the kiln liable to excessive subsidence on one side during the process of carbonization. To compensate for these drawbacks, it is more certain in its results, as unless the chimney is properly constructed and the fire skilfully stoked, fire lighted from above may fail to reach the bottom of the chimney, thereby rendering the carbonization of the lowest tier of wood a difficult matter, or at any rate entailing the overburning of the wood in the upper tiers after it has already become carbonized.

6.—*The process of carbonization.*

Whether the kiln is lit from below or from above, the whole of the wood in the chimney must be on fire before the burning is allowed to extend into the wood beyond.

Assuming that the wood in the chimney is fully ablaze first, the fire spreads thence outwards in the form of an inverted cone with an ever-widening base, until the whole of the kiln is on fire. This mode of progression of the fire is explained by the principle of the parallelogram of forces. The heated air and other gases tend to rise vertically, while lateral contact of the wood to be carbonized creates a tendency for the fire to extend horizontally. The resultant of these two tendencies is at first an oblique line not far removed from the vertical, and since the height to which the fire can extend is limited, and the temperature inside the kiln is constantly rising, the horizontal spread of the fire becomes more and more conspicuous until the whole of the wood at the bottom is carbonized. Thus the carbonization proceeds progressively from the top downwards.

During the process of carbonization large quantities of various gases are given off. The whole of these gases being unable to leave the kiln, what remains behind condenses inside and trickles down through the lower tiers of wood to the ground, where it is absorbed or from which it flows away through the foot of the kiln.

While any piece of wood is being carbonized, first of all steam, the characteristic colour of which is a bluish-grey, issues forth. This is followed by russet-coloured vapours, which would, if condensed, yield pyroligneous acid, tar, wood-spirit, &c. When the carbonization is complete, if the burning is still continued, a clear blue flame proceeds from the carbonized wood, proving that only charcoal is left and is being burnt away.

Some of the gases given out by the carbonizing wood form explosive mixtures with the oxygen of the air ; if they are not given a free vent, explosions will take place inside the kiln, disarranging the wood and causing the covering to burst.

7.—*Conduct of the carbonizing operations.*

If the formation and expansion of the fire-cone took place uniformly in every direction, all that would be required would be to keep the covering sufficiently pervious to air along the edge of the expanding cone (that is to say, at the level at which carbonization was going on) and to maintain it air-tight elsewhere, especially

over those portions of the kiln where carbonization was completed. Hence, the first thing that would be done after closing the flue of the chimney would be to pierce small vent holes, 1 to 2 inches in diameter and about 2 feet apart, all round the kiln a foot or so below the apex. The object of these holes, which could be easily made with a bamboo or sapling pointed with iron, would be to admit the necessary amount of air for carbonizing the wood at the top of the kiln and allow the vapours and other gases of distillation to pass out freely. When the carbonization at this level was complete, which fact would be recognized by the pale blue colour and transparency of the smoke, the holes would be closed and a new line of them opened 1 to 2 feet lower down. In this way the charcoal-burner would gradually effect the carbonization of the entire kiln, the natural spread of the fire-cone being aided and regulated by means of the holes. He would then cover up the kiln as thickly as possible in order to stop all combustion, and in a few days the kiln would have cooled down enough for the covering to be taken off and the charcoal removed.

Under actual conditions such extreme uniformity is unattainable, owing to several causes of irregularity, the principal of which are the following :—

(i). Inevitable defects in the packing of the wood, in consequence of which unequal draughts are produced, leading to more rapid carbonization and, therefore, more sinking at some points than at others.

(ii). Differences in the amount of moisture contained in different pieces of wood.

(iii). Difference of density, even when only a single species is used.

(iv). Movements of the atmosphere, from which the kiln can never be effectually screened.

(v). Unequal nature of the site.

(vi). Unavoidable errors of judgment, to which the most skilful are liable.

To overcome these various causes of irregularity requires no little skill and experience and unremitting care and watchfulness on the part of the charcoal-burner. To gain his end he must have recourse to one or more of the four following measures, which constitute the whole of his duties at the present stage of his work :—

I.—Erection of a screen on the windward side of the kiln.— The cheapest form of screen is one of thatch supported against upright posts firmly fixed in the ground. But the first precaution

to take, which may save the necessity of a screen, is to select a sheltered site with a close fringe of trees standing to windward.

II.—Increasing the draught.—Whenever unequal subsidence *takes place, there is proof positive that in the higher* portions carbonization has been going on more slowly than elsewhere. If the sinking at the lower points is not too rapid, then it is evident that the burning in the higher portions requires to be accelerated, in other words, that more air must be admitted inside them. This is done by making new vent-holes there or enlarging existing ones. The size of the holes and the intervals between them will depend on the degree of acceleration required. The new holes made need not be all at one and the same level.

Sometimes, it may happen that the rate of carbonization is everywhere too slow. The remedy for this is to make a line of vent-holes all round the kiln immediately below the level at which carbonization is actually going on. The object of these vent holes is not only to increase the inflow of atmospheric oxygen, but also to give free exit to the vapours given out during carbonization, the rapidity of which is impeded by them. The size of the holes and the intervals between them will depend on the amount of moisture in the wood and the slowness or rapidity with which the particular wood burns. If a screen has not been erected or the wind is constantly changing, no holes should be made on the windward side, and as the wind shifts about, some of the holes must be closed and new ones opened or enlarged. Every hole must be closed as soon as a clear blue flame or bluish transparent *vapours issue forth.*

The vent-holes are thus made to fulfil the double object (i) of securing equal combustion on every side, and (ii) of conducting the carbonization with the requisite speed. The necessity of vent-holes increases with the size of the kiln, and, under favourable circumstances, a small kiln situated in a sheltered spot may hardly require any at all.

III.—Diminishing the draught.—This is the opposite of the preceding operation, and consists in increasing the thickness of the outer covering wherever the kiln, by sinking too rapidly, affords a certain indication of over-rapid combustion. Over-rapid combustion can be detected even before sinking actually takes place: at such points an excessive quantity of dense smoke issues continuously.

As the carbonization progresses from the top downwards, the outer covering over the portions, where the process has just been completed, should be strengthened until no more smoke finds its way through it; and wherever, from any portion that has been

already carbonized, smoke is seen to come out, additional earth should be thrown on until it ceases.

The intense heat of the kiln bakes the moist covering of earth into a hard brick-like mass in which numerous cracks open out. It is impossible to close such cracks, and the only way to render the covering effective again is to quickly pull off the loose pieces of baked earth and replace them with fresh material. Some of the pieces may even be broken up fine on the kiln with a mallet. Not unfrequently it is impossible to stop smoke without moistening the outer covering; but the necessity for such action occurs only towards the end of the entire carbonization, when there is not sufficient humidity left inside to keep the covering moist with the vapours given out.

IV.—Filling up hollows.—However carefully the wood is packed or the regulation of the draught attended to, it is impossible to entirely prevent the formation of hollows owing to the wood at certain points burning so fast as to become partially or wholly consumed. If such hollows are not at once filled up, the further settling of the wood will cause the kiln to fall in at those points. Hollow places may be detected by beating the sides of the kiln with a club; where there is a hollow, the cover will yield or even fall in, or return the tell-tale sound.

To fill up a hollow the covering over it should be quickly torn open with a hoe and short billets of wood thrust in one after another as tight as possible, the covering being restored without delay. In doing this work the utmost dispatch should be used, and hence a quantity of filling and covering material, sufficient for all contingencies, should always be kept ready at hand. When the covering is cut open, a good deal of flame will issue through the opening.

General.—In order to do the needful at the right moment, the kiln should be constantly watched and tended by a number of men sufficient for all contingencies. For a single kiln containing up to 800 maunds of wood, or even for two kilns of that size, two men will suffice. During daylight the watching of the kiln and conduction of the burning offers no special difficulties; but during the darkness of the night accidents are especially to be feared, particularly if high winds blow. On this account, every evening, before nightfall, all hollows should be examined and filled up and all weak places thoroughly overhauled and strengthened. If the night is expected to be stormy, additional covering should be put on everywhere, and only just enough vent holes left open to prevent the fire from going out. Lastly, at short intervals all through the night, the kiln should be carefully examined on every side. Bun-

dles of dry grass should be kept handy, in order to get up plenty of light in case of accidents.

When, with the gradual downward progress of the carbonization, clear blue flames issue from the base of the kiln, the work is complete and the fire must be caused to die out without delay. This is done by shovelling on fresh earth and moistening the covering until smoke ceases to come out. A little superficial smoking, due to the conversion of the moisture in the covering into steam, must not be mistaken for real smoke. It is especially along the base of the kiln that draughts are likely to continue to enter, and it is here that the covering should receive extra strengthening.

8.—*Opening of the kiln.*

Even after the fire has gone out, the temperature inside the kiln will still be high enough to cause the charcoal to light up again, if air were admitted. On this account the kiln must be allowed to cool down sufficiently before it is opened. If we waited until the contents were cool enough to be comfortably handled, a week or even a whole fortnight might elapse. In practice, therefore, the work of taking out the charcoal may be commenced, according to the size of the kiln and the skill of the burners, from 1 to 3 days after the carbonization has been completed.

To prevent the charcoal from burning it should be taken out only at night, when the air is cool and damp and burning pieces can be at once detected by their glow and put out. The simplest plan to follow is to cut open a section of the kiln on one side, pull down quickly as much charcoal as possible, and cover up the kiln without delay. When so much charcoal has been picked out, another section adjoining the first should be pulled down, and so on until a complete circuit of the kiln has been made. If the remaining charcoal is also cool enough, a second and even more such tours of the kiln may be made. A small kiln may be emptied out in a single night; but usually the work requires at least two nights, as the charcoal in the centre is always hot enough to take fire readily, and covering it up for another night brings about the necessary reduction of temperature. The emptying of a large kiln may take several successive nights.

As the charcoal is picked out, it should be spread out on the ground, otherwise a single piece taking fire would set the whole heap burning. When spread out thus, individual pieces becoming aglow are detected at once and put out with a few drops of water.

The Indian charcoal-burner is often accustomed to empty out even a large kiln in a single operation, and to prevent all risk of fire, he deluges the hot charcoal with water. Nothing could be more reprehensible, as the moistened charcoal not only breaks up into innumerable small fragments, but also loses quality.

As soon as the charcoal is cool enough to be handled, it should be sorted and at once put away under shelter, for charcoal absorbs moisture greedily and becomes depreciated thereby. If there is a demand for it, the very small charcoal that is mixed up with the dust of the kiln should be sifted out, constituting then the lowest class of charcoal.

However skilfully the carbonization has been conducted, a very appreciable portion of the wood will always be found incompletely charred. Such pieces, as already recommended before, should be utilised in new kilns as filling material for the chimney and hollows and for placing next to the chimney. But if they are very numerous, it will be found convenient to complete their carbonization separately in a kiln made up entirely of such stuff; mixed up with fresh wood in any other manner than that indicated above, they would be reduced to ashes by the time the latter was carbonized.

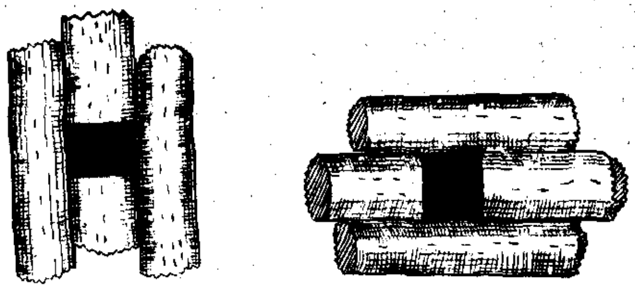
ARTICLE 2.—THE PARABOLOIDAL PIT-KILN.

In this system, a circular pit from 1 to 2 feet deep is dug, with a level bottom and sides sloping enough not to fall in. The bottom of the pit is first strewn over with a layer, from 4 to 6 inches thick, of dry leaves and twigs, and then the kiln is built up. The object of this foundation of loose and highly combustible material is (i) to preserve the wood to be carbonized from direct contact with the soil, which, besides that it may itself be originally moist, must, during the process of the carbonization, become sodden with the liquid products of distillation, and (ii) to ensure the fire extending amongst the wood at the bottom of the kiln. The pieces of wood to be carbonized are laid horizontally—some radially, others tangentially. Hence, to pack close, they must be of all sizes.* Before beginning a new layer, all empty spaces in the one just completed should be filled up with small pieces, preferably of dry wood. It is superfluous to add that every layer should be arranged as horizontally as possible.

The manner of forming the flue requires to be described. The billets forming its sides in alternate layers of the wood are arrang-

ed respectively as represented in *A* and *B* of *Fig. 68*. As the

Fig. 68.



Mode of constructing flue of horizontally-laid paraboloidal kilns.

horizontal position of the pieces precludes any tendency for them to fall in, no posts are necessary to support the sides; but to help to form the flue straight and vertical, a straight billet may be held upright in it until the kiln has been built up.

The firing can of course take place only from the top, in the manner described on page 140. The management of the covering is, however, at first different. Since there is absolutely no danger of over-rapid combustion within the pit, the sides at the ground-level should be kept open for some time to allow the fire to spread freely downwards, and, in order to prevent the wood at the top from burning too fast in the meanwhile, no vent-holes should be pierced there. It is only when the wood within the pit is in full combustion that the covering near the ground should be completed, but even then it should be lighter there than elsewhere, and a vent or two may have to be left on a level with the ground up to the very end of the carbonization. Some charcoal-burners, in order to introduce a draught into the pit, excavate a narrow oblique shaft in the sides of the pit at the two extremities of a diameter and opening into the bottom of the pit. Needless to say that the shafts are not closed at all until carbonization is complete.

By stacking horizontally we secure the very signal advantage of being able to utilise pieces of all lengths and thicknesses, thus saving the very heavy cost, imposed by the vertical method, of cutting up all the pieces to one length and of splitting them to more or less the same thickness, and also being able to build up a kiln with the produce of the few nearest trees. It is mainly on this account that the Indian charcoal-burner always lays his wood horizontally, and will have nothing to say to vertical stacking, even when the circumstances of the case render that method preferable.

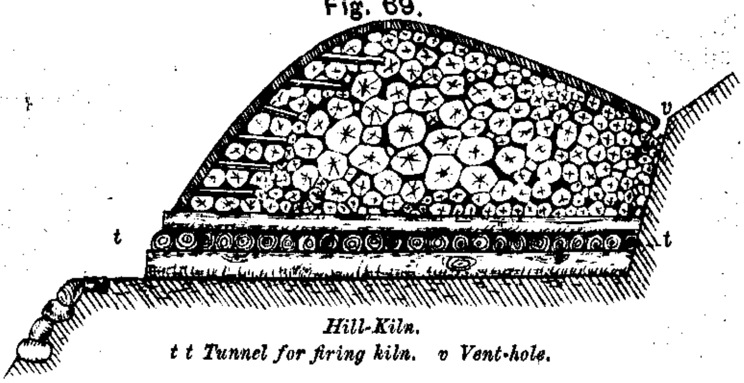
On the other hand, the packing in horizontal laying is extremely irregular and requires infinite pains to do well, and also consumes much time. It is for this reason that the overground form, the burning in which is so much easier to conduct, is so often given up for the rather primitive pit-form here described, in which loose and careless packing has not the same serious consequences. Although no exact figures are available, there are sufficient data to prove that the yield in pit-kiln burning is very much less than in overground burning, the outturn of charcoal seldom exceeding 15 per cent. of the wood used. It is, however, well adapted for charcoal manufacture on a small scale when skilful burners are not obtainable. The local name in the Dehra Dún for the pit-kiln is *bhadi ka bhatta*, literally, the carpenter's kiln.

ARTICLE 3.—THE HILL-KILN.

On hillsides the construction of any of the kilns hitherto described is out of the question; a level site of even quality could be obtained there only at prohibitive expense, and the draught from the four sides can never be made equal, being always greatest from the side of the valley and almost totally wanting on the side of the hill. Hence the necessity of constructing a special kind of kiln.

The terrace on which the kiln is to be built should be made to slope slightly outwards. The outer portion of the terrace, being necessarily made-ground and open towards the valley, is pretty freely penetrable to air. To neutralise this inequality, which is still further exaggerated by the absence of any draught from the side of the hill, the largest and hardest and greenest pieces should be packed at the valley end of the kiln, which should also be built up highest. Moreover, the kiln should, for obvious reasons, be made to lean up against the hill, and to this end the side of the hill should not be cut vertical but sloping at an angle of about 30° (*see Fig.* 69).

Fig. 69.



Hill-Kiln.
t t Tunnel for firing kiln. v Vent-hole.

To secure a through draught, a tunnel (tt) is left along the whole length of the kiln, and it is by this tunnel, which is afterwards filled with small combustible wood, that the kiln is fired. At v the covering is omitted, in order to draw the fire inwards and upwards. The fore end of the tunnel is left more or less open for several hours after combustion has begun. On its being closed, several holes are made both in the outer face and sides of the kiln and also one on each side of the vent-hole v, which itself is kept open until carbonization is nearly complete.

The outer face and sides of the kiln are often rather steep, and the covering of earth must then be kept in place with the aid of struts, as explained in *Fig.* 67 above.

In a report written by Mr. Heinig in 1880, whilst he was at the Forest School, he says that he found it an advantage to form a vertical chimney rising up from the inner extremity of the tunnel, and to fire the kiln through this chimney as well as through the tunnel. The chimney, no doubt, renders the firing very much easier, but its absolute utility has still to be proved by a larger number of experiments than he was able to try. The best way to secure the carbonization of the wood near the hill is to make the height of the kiln diminish towards the hill and to keep the vent-holes open on the top along the edge of the cutting.

With skilful burning, the yield in this style of kiln should hardly, if at all, fall short of that obtainable from any other kind of kiln.

Article 4.—The Prismatic Kiln.

The shape of the prismatic kiln resembles to a certain extent an ellipsoidal dome springing up from a rectangular base. If l and b be respectively the length and breadth of its base, and h its dimension where the height is greatest, then the stacked contents will be approximately $= \frac{1}{2}\ l\ b\ h$.

Such kilns are most conveniently built up with straight long pieces, of more or less the same thickness, running through the entire length of the kiln; but the prismatic shape is very frequently adopted even in the absence of such pieces, because it is on the whole easier to form and requires the wood to be much less cut up than the paraboloidal form, although it is, on the other hand, more liable to breakages from irregular settling and more difficult to cover properly. There is no chimney, but a tunnel is left along the ground running through the entire length of the kiln and filled with combustible material, which is fired at both ends. In India prismatic kilns are usually made much larger than paraboloidal ones. The outturn of charcoal does not differ materially from that

obtained from the latter class of kilns when these are built up with horizontally-laid wood.

SECTION III.—CARBONIZATION IN OPEN PITS.

The pit is from 3 to 5 feet deep and 5 feet and upwards in diameter, the sides being made sufficiently sloping to support themselves. First of all, it is filled up with dry twigs and branchlets, which are fired and allowed to burn down freely. When the burning has progressed so far that the wood inside is all aglow and has ceased to give out any smoke, the first instalment of the wood to be carbonized is thrown in. This wood is allowed to burn on until, in its turn, it no longer emits any smoke, when a second instalment is thrown in. This process is repeated until the pit is full of glowing coal. The entire glowing mass is then covered up with a layer of moist earth, thick enough to exclude air. After two or three days the pit will be sufficiently cool to be opened and the charcoal taken out.

This is an extremely wasteful way of making charcoal, but as it requires no skill at all and next to no supervision, it may be adopted where there is plenty of waste wood that has no other use and the demand for charcoal is relatively small.

SECTION IV.—YIELD OF CHARCOAL.

The yield will depend on various circumstances, the principal of which are—

1. *The nature of the wood used.*—Dry wood yields more charcoal than moist wood; resinous and oily woods more than other kinds (since both the resin and the oil contribute a large proportion of the heat necessary for the carbonization); and soft woods more than hard woods (since the volatile products of distillation are more easily expelled from the looser tissues of the latter). Branch-wood, as it contains more reserve materials and less ligneous matter, yields less charcoal than the wood of the stem.

2. *The nature of the site.*—On a site that is uniform throughout and is well-sheltered, and is also one that has been frequently used before, so that its peculiarities are thoroughly known, the yield will obviously be largest.

3. *The state of the weather.*—Still weather is much more favourable than windy weather, especially if the wind constantly shifts or blows in gusts. Very dry weather is just as unfavourable as steady rainy weather. In dry weather the covering breaks

open very frequently and requires to be constantly moistened; on the other hand, in rainy weather the covering remains so moist that the steam and other vapours, which form in the interior, do not find sufficient vent, and carbonization is consequently retarded, and, if the rain is heavy enough, the covering may be washed away. When carbonization in wet weather cannot be avoided, a thatch roof should be put over the kiln.

4. *Proper control of the carbonization.*—The yield is largest when the progress of the fire is uniform in every direction. In the contrary case, those portions which, having become carbonized earliest, are kept on burning until the carbonization of the rest is complete, lose a more or less considerable portion of their carbon. Gradual burning, and especially slow burning at the commencement, yields not only a larger outturn, but also heavier charcoal. The number of times the covering breaks open or has to be opened to fill up hollows, and slowness or awkwardness in restoring it or in filling up the hollows, result in a very appreciable loss of carbon. To avoid such loss, the wood should, in the first instance, be packed as carefully and as closely as possible, and once the kiln is in full combustion, the chimney and, if the kiln is lighted from below, also the tunnel along the ground should be filled up tight.

5. *Time occupied in carbonization.*—It has already been said that rapid burning results in unnecessary loss of carbon and that moderately slow burning gives the largest yield. The length of time occupied in carbonization will vary between certain wide limits depending on the style and dimensions of the kiln, the size of the pieces of wood, the moisture they contain, the quality of the site, the nature of the weather, and the care with which the kiln has been built up. Small kilns, containing from 500 to 1,000 cubic feet of moderately hard, fairly well-seasoned wood, will require from 6 to 8 days. Large kilns, containing from 3,000 to 8,000 cubic feet of similar wood, will require 4 weeks in favourable, and from 5 to 6 weeks in unfavourable weather. Green wood will, in every case, take half as much time again as dry wood.

6. *The method of carbonization adopted.*—In the paraboloidal over-ground kiln the yield is generally increased by firing from below, as the wood in the chimney then takes fire more readily and completely, and the fire cone progresses more regularly and uniformly. When the chimney is lit from above, the fire does not often run down to the bottom quick enough to enable it to be refilled with wood to be carbonized. The result is that, after a little

time, the small wood in the chimney is consumed to ashes, a hollow is formed, and the kiln falls in at the top. When the wood is laid horizontally, it does not matter whether the chimney is fired from above or below, as the position of the pieces prevents them from falling in.

The yield is largest if the carbonization is effected with special apparatus, and least in an open pit.

7. *Skill and zeal of charcoal-burners.*—This is self-evident.

General.—We may now enter into a few general considerations. Assuming that we have used fairly well-seasoned, non-resinous, and non-oily wood, we would still have roughly 20 per cent. of moisture, 50 per cent. of the balance being carbon; so that if no carbon were lost in carbonization, the yield (a purely hypothetical one) would be 40 per cent. But actually, according to Boppe, the following losses occur :—

1.	To raise the kiln to red heat, ...	1	per cent.
2.	To expel the moisture, ...	$5\frac{1}{2}$	„
3.	By loss of heat radiated, ...	1–2	„
4.	Carbon carried off in combination in the various products of distillation, ...	11	„
	Total loss, ...	$18\frac{1}{2}$–$19\frac{1}{2}$	„

Thus the highest theoretical yield in carbon can never exceed about 21 per cent. of the weight of the wood. Adding up for mineral matter and the small quantity of oxygen and hydrogen contained in charcoal, the highest yield in charcoal we may expect is 23 per cent. This figure is completely justified by facts, for resinous or highly oily woods burnt in open kilns yield 25 per cent. by weight of charcoal, and other species only from 20 to 23 per cent.

The total shrinkage in volume may be put down at from 55 to 60 per cent. for resinous and oily woods and from 40 to 50 per cent. for other kinds.

The shrinkage in girth varies between 16 and 25 per cent., that in length amounting to only about 12 per cent. Hence the kiln will sink most when the wood is laid horizontally. The sinking will always be in excess of the figures given above, as a good deal of the charcoal breaks up, the broken pieces sliding in between those lower down.

Weighing the charcoal soon after it has been taken out of the

kiln or oven always gives the outturn more accurately than measuring it, as the density of the charcoal will be different according to the wood used and the quality of the charcoal. Nevertheless, as the weighing of a light bulky article is always a slow and tedious process, it is best to ascertain the quantity of the charcoal by measure. This is usually and most conveniently done with baskets of known capacity. If the weight also is required, it is easy enough to weigh a few basketfuls and strike a mean for the weight of one basketful.

SECTION V.—TESTING CHARCOAL.

Charcoal may be described in general terms as a black, more or less lustrous and porous, but fairly compact, substance, of low specific gravity, and possessing neither smell nor taste. These properties are subject to some slight modifications according to the wood from which it is made. We have already seen that the specific weight is, for all practical purposes, directly proportional to the density of the wood; the heavier the wood is, the heavier will be the charcoal. We know, too, that the weight of charcoal also depends on the dryness of the wood and the slowness of the carbonisation.

Good charcoal is black with a steel-blue metallic lustre, and has a conchoidal fracture. If the kiln has been kept burning too long, that is to say, if the wood has been allowed to burn on for some time after it has become carbonised, the charcoal assumes a deep black colour, and loses its characteristic lustre; it also becomes porous and lighter. On the other hand, if the carbonisation is incomplete, the charcoal is of a foxy-red colour, and emits a heavy smoke in burning. Good charcoal gives out a clear metallic ring when struck or when thrown together or stirred about; whereas overburnt charcoal returns a very dull clink and insufficiently burnt charcoal a deader sound even than wood. Both good charcoal and overburnt charcoal burn without smoke; but the latter emits no flame at all, takes fire almost instantaneously, and is very quickly consumed.

Charcoal possesses great power of absorbing gases; from moist air it will take up watery vapour sufficient to increase its weight from 8 to 12 per cent. It also absorbs water with avidity, taking up from 25 to 30 per cent. of its own weight in a few minutes, and from 60 to 120 per cent. in the course of only 8 hours. Hence the sale of charcoal by weight leaves much room for fraud and should never be employed.

CHAPTER II.—PREPARATION OF CUTCH AND KATTHA.

These two substances, popularly regarded as more or less identical, are really entirely distinct. The wood from which both extracts are obtained is principally the *Acacia Catechu,* although that of the very much less common *Acacia Suma* also yields them. These woods are impregnated with a mixture of catechu tannin and catechin, so that the extract contains both substances intimately mixed together, and it is cutch or kattha according to the respective proportions of these two substances present in it. Whether a tree will yield kattha or catechu is at once ascertained by cutting into the heartwood and noting the abundance or otherwise of white spots on the section; these white spots are incrustations of catechin. If the proportion of white spots is very small, cutch is the produce obtained.

The extract of both kinds is prepared in a similar manner. The heartwood is split up into thin chips with an adze. The chips are boiled for one or more hours in an earthen vessel, and the solution obtained is poured on to fresh chips and boiled over again. This process is repeated until the liquor acquires the consistency of a very thick syrup. For the preparation of kattha this syrup is boiled, still in earthen pots, until it becomes a thick paste, when it is cooled and poured off into moulds scooped out in fine dry sand. As a result of the cooling, the catechin crystallises, while the tannin, still in a state of solution, is to a great extent absorbed by the sand. Thus what is left behind is catechin with a small proportion of tannin. In Burma, where it is cutch that is prepared, the syrup is poured into iron pans, in which it is boiled down to a thick paste, this paste solidifying on cooling. Iron has such a great affinity for catechin, that the boiling in the iron pans destroys most of the catechin in the extracts.

Both the methods just described are extremely clumsy and slovenly, as the dried extract often contains more than 4 per cent. of wood, while in the kattha there may be further admixture of as much as 16 per cent. of sand. If the manufacture were taken in hand in a systematic manner on scientific principles, special apparatus could be introduced, which would not only save labour, time, and, therefore, money, but also give only the purest products in the largest quantity obtainable. Dr. Warth recommends the following process :—Shave the wood fine (about one-sixteenth of an inch thick) on a lathe, steam the shavings in special copper pans and boilers, cool the extract to precipitate the catechin, get rid

of the liquid portion in a filter press, and finally dry, in vacuum pans, both the filtrate and what remains on the filter, the former yielding the tannin, the latter the catechin.

Dr. Warth has proved that catechin is very quickly decomposed when in a state of solution. Even pure catechin, dissolved in water and at once recrystallised, loses, on an average, 32 per cent. of its original weight. Dr. Warth has also shown that catechin is soluble only in hot water, whereas tannin is soluble at all temperatures; and that whereas, when in solution by itself, catechin separates from the liquid without any delay if the solution is cooled down sufficiently, it takes days to be precipitated, under mere exposure to air, if tannin is also in solution with it. This demonstrates the necessity of shortening the process of manufacture as much as possible. Hence the necessity of steaming instead of boiling, and of the filter press and vacuum pans instead of slow precipitation and evaporation in open vessels or moulds. Bazar kattha made in Oudh, analysed by Dr. Warth, yielded on recrystallisation an average of only 36 per cent. of catechin, whereas by Dr. Warth's process the extract would be pure, or very nearly pure, catechin.

Although catechin decomposes so easily in solution, yet in its crystallised form it will keep unchanged for years. Hence the practice of selling it in the bazars in a liquid form is a bad one.

The market for both cutch and kattha being, in comparison with our forest resources, practically unlimited, there is no reason, with fairly high ruling prices, why in one and the same forest both cutch and kattha should not be made together, as suggested by Dr. Warth. By this means, all the khair trees of a coupe would be utilized, instead of, as at present in the case of kattha manufacture, only those which exhibit numerous white markings. In this way, the present enormous waste of khair trees would be stopped and the value of the khair forests at once increased two to tenfold.

In Dr. Warth's experiments well-marked Oudh wood yielded 9 per cent. of catechin and 15 per cent. of tannin, while wood rejected by the kattha boilers contained 3·7 per cent. of catechin and 12 per cent. of tannin; on the other hand, of the Burmese wood the unmarked variety gave only 2 per cent. of catechin and 14 per cent. of tannin, while the most conspicuously marked specimens yielded from 5 to 6 per cent. of catechin and 14 per cent. of tannin.

The figures just quoted prove that with improved methods of

manufacture every khair tree, including those at present rejected by the kattha boilers, will furnish catechin in paying quantities, while the yield of tannin, so large a proportion of which is now deliberately sacrificed by absorption in the sand, will be all saved for export to Europe.

CHAPTER III.—DISTILLATION OF SANDALWOOD OIL.

The distillation is effected by the wet process in temporary sheds erected in or near the forest. The still used is the ordinary Indian one consisting of three pots, *viz.*, two large ones, doing duty respectively as boiler and condenser, and a third, a small copper one, which is inverted into the mouth of the boiler and is practically the cap of the still. It is fitted with a copper or bamboo tube about 4 feet long and having a bore of about 1 inch, which carries down the vapour into the condenser. The boiler, which may be of metal or ordinary earthenware, holds about 56 lbs. of sandalwood chips with about 6 gallons of water. The sides of the boiler and cap are carefully luted together to prevent the escape of steam. On one side of the boiler is a small opening which can be stopped and through which fresh water can be added as the water inside is evaporated. The condenser is made of copper and has a capacity of about 3 gallons. Its mouth is stopped with leaves and coarse grass, and it is suspended on a forked piece of wood by its contracted neck inside a wide earthenware trough filled with cold water, which is constantly renewed. Several such stills, usually twelve, are fixed in a row over a common furnace made of mud or unburnt bricks. The furnace is actually fed from the back under each boiler, but it would be better to stoke it at one end, the opposite end serving as a chimney to draw a constant draught through.

The wood is shred into fine chips with a small sharp adze. As the condenser gradually fills with water and oil, the latter is skimmed off (twice or thrice in the 24 hours) and emptied into a cistern or narrow tank kept in a corner of the shed. Only a small quantity of oil is obtained at each skimming. The fires burn night and day, and a single charge of wood takes about 21 days to part with all its oil. The working season lasts 10 months, during which, however, owing to constant holidays and slackness on the part of the men, the boilers are charged only about nine times.

The wood of the root contains the largest quantity of oil, and is said to yield, according to its quality, from 1½ to 4 per cent. of

its weight of oil, although European distillers have never been able to get more than 2 per cent. The sapwood is too poor in oil to be of any use.

CHAPTER IV.—MANUFACTURE OF THE VARIOUS PRODUCTS DERIVED FROM TURPENTINES.

Every turpentine consists of an essential oil and of a solid substance (colophony) in solution in the oil. By distilling the oil at a temperature of 158° C. (the boiling point of the oil), the colophony or resin is left as a residue.

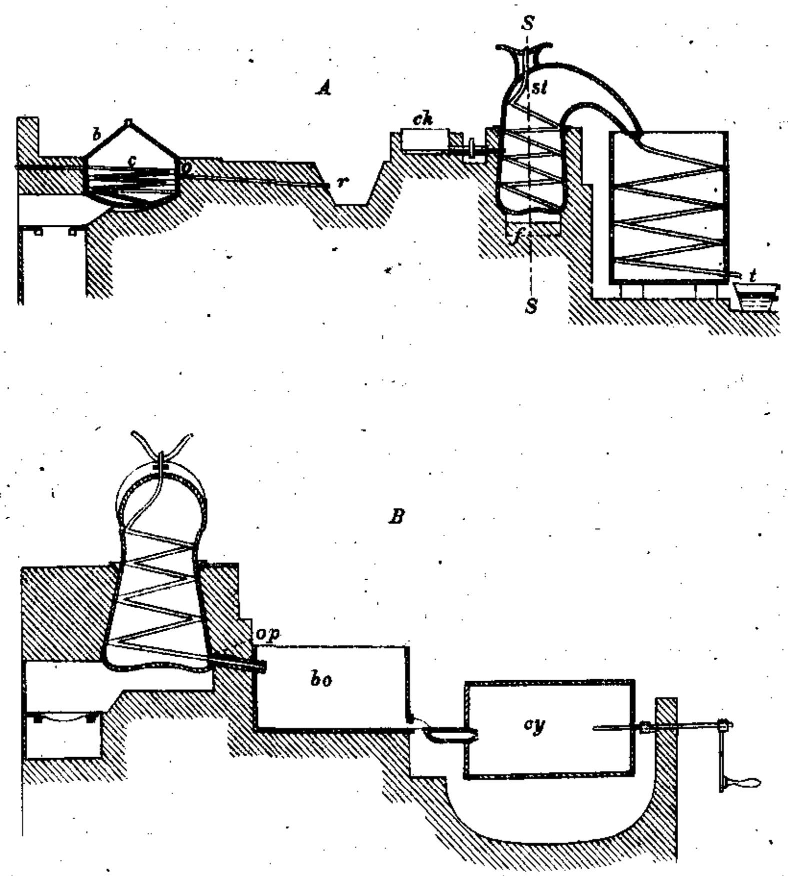
The mode of distillation followed by the natives is a very primitive one. The apparatus employed is similar to that already described in the preceding chapter. Not unfrequently no water at all is used, so that the colophony gets more or less burnt, and some acetic acid, alcohol, naphtha, and other impurities are produced and distil over with the oil.

A great improvement on this rude mode of distillation is easily effected with apparatus of almost equal simplicity and of scarcely higher cost. The crude resin should first be raised to a temperature just high enough to liquefy it, and passed through a sieve to free it from pieces of bark and other impurities. It should then be run into the boiler of a still, heat being applied, either by an ordinary furnace or a steam-jacket, until the mass attains a uniform temperature of 100° to 158°. This temperature should be continued until the accidental water contained in the oleo-resin has been driven off, together with pyroligneous acid, ether, and methylic alcohol. A thin stream of water should now be admitted, so that the temperature may be kept at or below 158°. The distillation will continue, water and turpentine oil passing over into a receiver fitted with two taps, one at the bottom, the other higher up; the water is drawn off from the former, the oil from the latter. The progress of the distillation should be judged by means of samples taken at intervals in a graduated measure. When the distillate shows only a very small percentage of oil, the still-cap should be removed, and the hot liquid rosin or colophony drawn off by a tap near the bottom of the boiler and at once run through a fine sieve. Lastly the slight quantity of oil remaining may be driven off by heating the resin in an open pan.

There are now many improved methods of distillation, which, however, require special elaborate apparatus. One of these is

represented in *Fig.* 70. The first purification of the crude oleo-

Fig. 70.



Apparatus for distilling turpentine.
B is a slightly enlarged section on SS in A.

resin is effected in the boiler *b*, which has a moveable lid and through which runs a steam-coil *c*. At *o* is an orifice with a grating. All the liquefied material which reaches above *o*, runs out into the receptacle *r*, so that there remains behind in the boiler only a small quantity of resin mixed with foreign matters, such as chips of wood and bark, leaves, sand, &c. The filtered resin is transferred from *r* to a reservoir *ch*, called the charge, holding the exact quantity (about 66 gallons) for each operation. From this reservoir the resin is introduced into the still *st*. In the still a

perforated worm permits of the introduction of steam when the resin, heated by the fire at *f*, has attained a temperature of 135°. Effervescence ensues and the oil separates completely from the colophony, passing over, with the steam, into the serpentine condenser, whence it falls into the tub *t*. The tub is furnished with two taps, by means of which the oil and water are drawn off separately. At the bottom of the still is an opening *op*, which is closed with a bung and carefully luted. When the oil ceases to pass into the condenser, the distilling operation is stopped and the bung removed. The colophony, at a temperature of about 130°, escapes into a box *bo*, and thence into a revolving cylinder *cy*, formed of very fine metallic gauze. The colophony falls through into a receptacle, while an unimportant residue is left inside. The oil, on passing out, is cloudy, but after standing for four to five days in large earthenware jars or copper pots, clears up, the small quantity of impurities present becoming precipitated. To prevent the solid matters in the resin from burning, the boiler *b* may be fitted with an agitator. Moreover, steam alone may be employed throughout the operation, thus avoiding all risk of burning.

There are different grades or qualities of colophony. The first exudations from new or recently freshened blazes give the best kinds, while the hard or semi-hardened concretions (*thus*, *scrape*, in French, *galipot* and *barras*, the latter being the scrapings containing débris of wood and bark) yield an inferior yellow resin. The lowest class is furnished by the distillation of the filtration residues left in the manufacture of the better kinds. If, while the rosin is still liquid, some water is added and the whole is briskly agitated, opaque rosin is obtained owing to the formation of abietic acid.

The pitches are produced either by a further distillation of the tar obtained in the dry distillation of highly resinous wood or by the distillation of the filtration residues left in the various processes followed for separating the oil from the colophony. In the more primitive of these processes the filtration of the crude resin and colophony is effected through mats. The mats, with what is left thereon, are placed in a brick furnace (*Fig.* 71). Fire is kindled at the top and the resinous matters escape into the cooler *c*, the ashes being removed through a passage

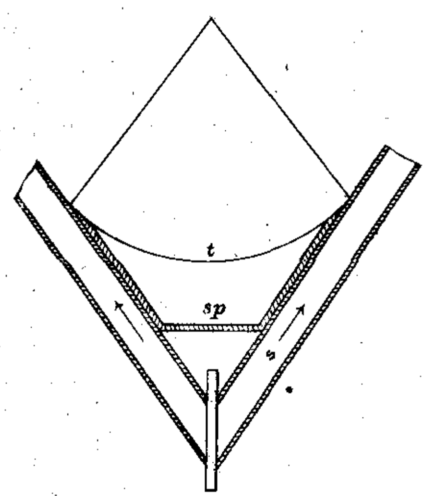
Fig. 71.

Kiln for manufacture of black pitch.

existing at *a*. What passes into the cooler consists of two portions, one of them a nearly solid one, which sinks to the bottom and is black pitch. It is an opaque, black substance, with conchoidal fracture, peculiar unpleasant odour, scarcely perceptible flavour, dissolving in the same menstrua as tar, and capable of being kneaded when softened by the heat of the hand.

In works having the modern improvements, the only residues are those left in the boiler (*Fig.* 70, *b*). These residues are filtered through mats and afford a little more crude turpentine. The mats, with all the impurities, are then placed in the apparatus shown in *Fig.* 72, which consists of a double-lined trough, with steam circulating in the intermediate space *s s*. The residues are put on the metallic gauze tray *t*, and the trough is covered to prevent evaporation of the essential oil. Under the influence of the heat, the turpentine falls into the space *s p* below. It is then distilled in the apparatus represented in *Fig.* 70, and yields a light-coloured pitch, with a little oil. The straw mats are finally treated as in the preceding case and afford black pitch. From the light-coloured pitches is manufactured the common yellow rosin, which is used for sizing the inferior kinds of paper, in soldering metals, and for rendering chips of wood combustible for lighting fires. The pitch used for caulking is one of the light-coloured kinds, but may be specially prepared by melting together, in certain proportions, colophony, black pitch, and tar.

Fig. 72.



Apparatus for clearing filtration residues in making light-coloured pitches.

The better kinds of colophony are used principally in the manufacture of paper, of soap, of sealing wax, of varnishes and of cements, and in the preparation of ointments. The different purposes served by oil of turpentine are too well known to need mention. The cleaner *scrape* (*galipot*) enters directly into the composition of certain varnishes, and is largely employed in the dockyards for painting over masts and the sides of ships.

Filtered crude turpentine is used in making varnishes, lithographic ink, and sealing wax. In France this filtered turpentine is called *pâte de térébenthine*, and is of three grades. The first is nothing but the purest portion of the crude filtered oleo-resin before distillation ; the second is the filtrate obtained by exposing the crude oleo-resin to nothing stronger than the heat of the sun ; while in obtaining the third, or best kind, only the ordinary temperature of the air is employed. *The price of this last kind is at* least six times higher than that of the other two kinds ; but the yield of it is proportionately very small.

All the refuse of manufacture of the preceding articles may be burnt in closed chambers to produce lampblack. Lastly, if the crude turpentine is obtainable in sufficient abundance and at low rates, gas for lighting purposes may be manufactured from it.

CHAPTER V.—IMPREGNATION OF TIMBER WITH ANTISEPTIC SUBSTANCES.

When durable timber is not obtainable in adequate quantity and at sufficiently low rates, inferior kinds have of course to be used. In that case, their durability may be increased by impregnating them with an antiseptic substance, that is to say, with a substance that opposes decay and the attacks of insects.

SECTION I.—THE VARIOUS ANTISEPTIC SUBSTANCES USED.

A great many kinds have been tried, but those most generally in use are—

(1). *Sulphate of copper.*—The cheapness and abundance of this substance and the ease with which wood can be impregnated with it are greatly in its favour ; but it makes the wood brittle and less resisting to strains, and as it never combines with the wood fibre, but is merely deposited in the interstices of the wood in the shape of crystals which are readily soluble, it ultimately gets washed out when the wood is placed in situations in which it is exposed to heavy rain or an overflow of water. Its employment can, therefore, never become general, and actually its use is confined almost *solely to a few railway lines in France, the country of its* origin, where beech sleepers are often thus impregnated.

(2). *Creosote.*—This is the creosote of commerce, and is really tar oil containing a certain proportion of creosote. It is a substance obtained in great abundance from coal, and is cheap enough in coal-producing countries. Immediately after impregnation the wood is quite soft, but it soon blackens and becomes harder, but

rather more brittle, than it was before. The creosote is absorbed into the substance of the wood-fibres, of which it therefore becomes an integral part, and it can hence never be washed out. Its oily nature renders the wood more or less damp-proof, so that it diminishes the tendency of the wood to warp and split.

(3). *Chloride of zinc.*—This is a cheap substance and is very effective against decay, but does not come anywhere near creosote in practical utility.

(4). *Chloride of mercury* (corrosive sublimate).—The use of this substance for impregnating wood was first made by an Englishman named Kyan, whence the name of *Kyanizing* for the process invented by him. Corrosive sublimate is thoroughly effective against every kind of decay and insects, but its violently-poisonous nature and its high cost are against its employment.

(5). *Carbolic acid.*—This is used either by itself or in mixture with other substances, but is too expensive for ordinary employment.

(6). *Tar oil, paraffin, benzene, and other carbo-hydrates, derived from the dry distillation of coal and wood.*—These substances are injected in combination with steam, but their use has not yet become general.

(7). *Ferric tannate.*—This is a compound of iron and tannic acid. It is perfectly insoluble, and hence, when it once gets inside the wood, nothing will remove it. By closing the pores of the wood into which it is injected, it effectually keeps out moisture. As the salt is insoluble, the wood is first injected with tannic acid and then with ferrous oxide, or, which comes to the same thing and is very much cheaper, pyrolignite of iron. The two substances combine in the wood to form the ferric tannate.

SECTION II.—METHODS OF IMPREGNATION.

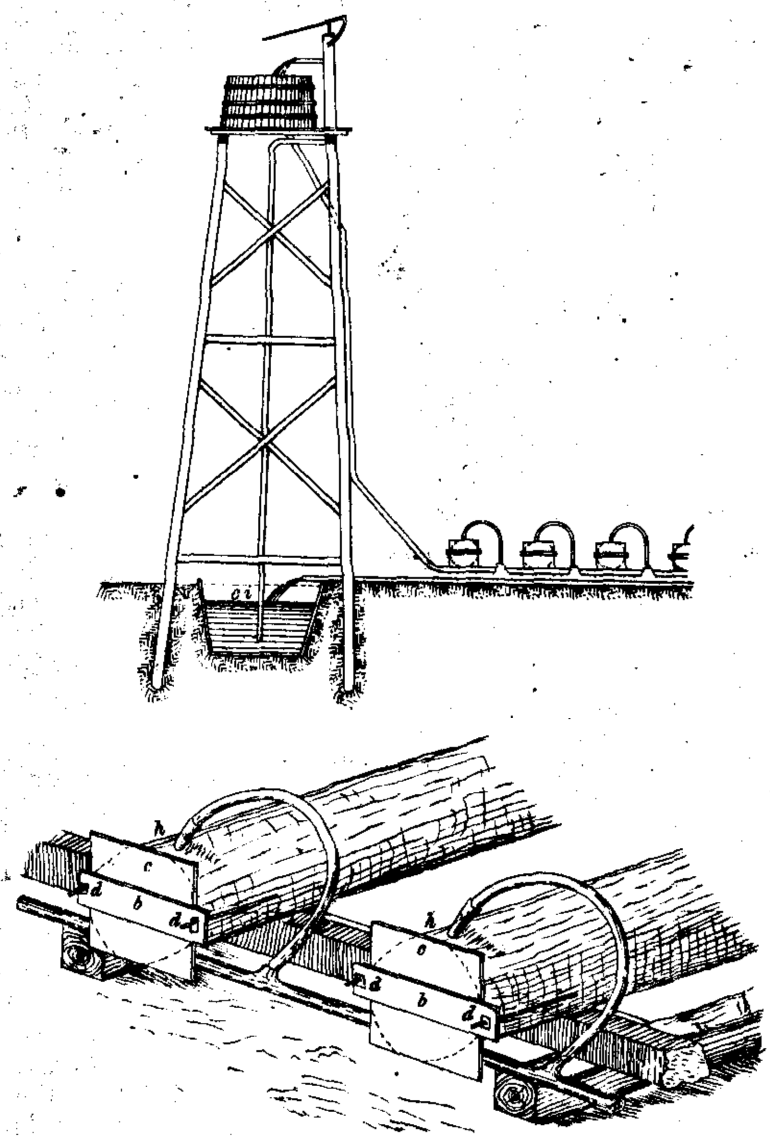
Impregnation may be effected either (1) by hydrostatic pressure, or (2) by pneumatic pressure, or (3) by immersion, or (4) by painting the surface of the wood.

ARTICLE 1.—THE HYDROSTATIC METHOD.

By this method, which was the first one ever used and was invented by a French Doctor named Boucherie, wood can be impregnated only while it is still quite green. The sap of the green wood is driven out by the antiseptic liquid, which is placed at a sufficient height to exert a pressure of about one atmosphere. The wood to be impregnated must not be barked, otherwise much of the antiseptic fluid would escape at the sides and the entrance of air would interfere with the free run of the liquid. The pieces are

generally placed with the thicker end slightly raised above the other. *Fig.* 73 shows clearly how the impregnation is effected.

Fig. 73.

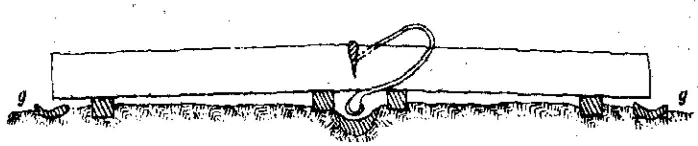


Boucherie's apparatus for impregnating timber.

The raised end of the log is sawn off with a clean section and covered with the cap (*c*), which consists of a square board and a ring of tarred rope placed between it and the log. The cap is pressed up against the log by the dog-bolts *d d*, the free ends of which pass through the batten *b* and are fitted with screw nuts, An oblique hole (*h*) is bored, into which is inserted the nozzle of a gutta-percha tube connected with the elevated reservoir of antiseptic liquid. The reservoir is placed about 30 feet above the ground in order to secure the required pressure of one atmosphere. Under this pressure the liquid drives before it the sap in the wood. At first, the pure sap runs out at the other end of the log in a continuous trickling stream. Later on, the sap is mixed with the antiseptic substance, the proportion of which of course increases as the sap remaining in the log diminishes, until no more sap is left and only water containing the antiseptic substance oozes out. To ascertain whether the wood is sufficiently impregnated, chips are removed from it from time to time and examined. The impregnation is complete before the liquid that runs out of the log is of the same strength as the solution in the reservoir.

The process is very considerably shortened by impregnating at once logs of double the required length. In this case the log is sawn through the middle for about three-quarters of its thickness. It is then raised in the middle so as to make the cut gape open and a piece of tarred rope is let in along the circumference. On letting go the log, the sides of the cut close tightly upon the rope, and form with it a completely water-tight chamber. A single oblique hole with inserted tube suffices to impregnate both halves of the long log. *Fig.* 74 renders the preceding explanation clear.

Fig. 74.



Mode of impregnating two lengths of log in a single operation.

To prevent waste of the antiseptic substance, the fluid that runs out from the free ends of the logs falls into gutters *g*, whence it flows away into the cistern *ci* at the bottom of the platform. From this, the liquid, after being made up again to full strength and, if necessary, freed from organic matters, is pumped up into the re-

servoir above. The timber-yard is accordingly intersected with a well-devised system of masonry or asphalte gutters.

The substances injected in this manner are principally sulphate of copper and chloride of zinc. The strength of the sulphate solution is 1 of salt to 100 of water.

One important advantage of the hydrostatic method is that it involves only a very small capital outlay and requires no special mechanical skill to work. On the other hand, it has two disadvantages, which are great enough to militate against its general adoption. In the first place, wood in the round has to be used, so that all the portions (at least 30 per cent.), which fall off in conversion, are wasted, and thus a very large proportion of the antiseptic substance is lost. In the second place, as the wood must be green and also have its bark on, no conversion in the forest is possible, and thus cost of carriage is made a very heavy item.

Article 2.—The Pneumatic Method.

This method is of English origin. The wood, fully converted, and seasoned or unseasoned (the former the better), is placed in an air-tight chamber. This chamber is completely exhausted with an air-pump, an operation which draws off all the moisture from the wood. This result is aided either by heating the chamber or by filling it, previous to working the air-pump, with steam raised to a temperature of $112\frac{1}{2}^\circ$ C. and then condensing the steam to form a vacuum. Into the exhausted chamber the antiseptic solution is allowed to flow in, and, with the aid of a forcing pump, the pressure of the liquid is raised to that of nearly seven atmospheres. At the end of from 45 to 75 minutes the impregnation is complete. The liquid filling the chamber is then drawn off through a pipe at the bottom, and the chamber is opened and the wood taken out.

The substances injected in this way are creosote, chloride of zinc, sulphate of copper, tar, and ferric tannate. Carbolic acid, added in small proportions, increases the effectiveness of chloride of zinc. Creosote is the substance most largely injected by the pneumatic method. In using it the temperature in the chamber is raised to 130° C., and in order that the wood may become perfectly dry, it is kept inside the chamber for about two days before the creosote is let in. The chamber is large enough to hold several tons of wood, and the wood is brought into it on trucks moved on rails.

Another form of the pneumatic method, which is daily gaining on public favour, consists in injecting steam saturated with the

antiseptic substance, instead of using a liquid solution. The wood in the chamber remains exposed to the vapour during 6 to 20 hours.

The pneumatic method possesses advantages which render it the most practical of all those yet invented. There is no waste of wood in it, and the wood may be in any condition of seasoning. On the other hand, it requires very expensive plant, which places its adoption beyond the reach of small capitalists.

Article 3.—The Immersion Method.

This method is the simplest of all. The wood, after it has been thoroughly seasoned, is plunged into a bath containing the antiseptic substance.

The more prolonged the immersion is, the more fully does the wood become impregnated, and hence the more durable does it become; but it has been found that very long immersion has the effect of rendering the wood brittle, and 24 hours are considered sufficient. No portion of the wood should be allowed to remain outside the liquid, so that light wood must be sufficiently weighted to remain below the surface. The higher the temperature of the liquid is, the more rapid and effective is the impregnation. Small pieces of timber may be boiled in the bath.

The substances experimented with in this method are chloride of zinc, sulphate of copper, creosote, sulphate of iron, and tar. The first three, being poisonous, cannot come into general use. The strength of the sulphate of iron solution employed is 15 parts of sulphate to 100 of water. Tar has to be maintained at a temperature of 143° C. during the immersion. Except in the case of thin pieces of timber, or when immersion is prolonged beyond the usual duration, the antiseptic substance seldom penetrates into every portion of the tissues, and at any rate does not penetrate equally everywhere. This is, however, not always a drawback, as impregnation of merely the outside tissues will generally suffice to prevent fungoid growth finding an entrance into the interior.

Article 4.—Painting over the surface of the wood.

Oily and resinous substances in a liquefied condition, if brushed thickly over the surface, enter into and fill up sufficiently the outer tissue to increase very considerably the durability of timber, provided cracks extending beyond the impregnated shell do not form. Timber used under complete exposure to atmospheric influences is tarred with excellent results.

GRAPHIC METHODS OF EXHIBITING THE NATURE OF FOREST SOILS AND CROPS.

In an article which appeared in the *Revue des Eaux et Forêts* for the 10th June, 1890, Monsieur Marcel Volmerange writes as follows :—

" One of the most troublesome portions of a Working-Plan report is the description of the compartments. This requires much minute care on the part of the writer as it does steady attention on the part of the reader, and after all it is extremely difficult from a perusal of it to gather any idea of the forest in its entirety.

" A graphic representation of the elementary composition of the forest would probably give a better general idea of its condition and contents with far less trouble.

" Such a method would consist in showing on a sketch map the principal factors of the crop by conventional signs, different colours being used to show the species of trees, such as the following for example :—

Seedling crop, ...	o o o o o o
Thicket of saplings, ...	8 8 8 8 8 8 8
Pole crop, ...	+ + + + + +
Young high forest, ...	× × × × ×
Mature high forest, ...	— — — —
Over-mature or decaying high forest,	= = = =

Complete crops might be indicated by a continuous line.

" These conventional signs, or such others as might be preferred to them, could be used in various combinations, and would thus enable the composition of the forest in each compartment to be shown with whatever degree of accuracy or detail desirable, and a general idea of the forest as a whole could be gained from a simple inspection of the map.

" In order to complete the description, a few lines would be sufficient to explain the nature of the soil, unless it was thought practicable and not too difficult to show also the quality of soil by a similar method of the conventional signs and colours.

" It would also prove interesting, after the lapse of a certain number of years, to make a new map, using similar signs, which, by comparison with the old map, would at once show the alterations and improvements in the condition of the crops, and would facilitate the determination of the changes required in the treatment.

" In writing these few lines, the writer's idea has been to put forward a plan which, improved and further developed, ought to furnish a simple practical means of showing the composition of forest crops."

It may be interesting to compare the above method with one which has recently been independently worked out in India by the

late Chief Commissioner of the Central Provinces in consultation with the local Forest Officers and Colonel Wilmer, Deputy Superintendent of the Survey of India.

In a Note on the subject Mr. Mackenzie wrote :—

"Before leaving Nagpur last September, I consulted the Conservator, Colonel Doveton, as to whether we could not make use of the professional parties now engaged in Forest Survey to get together information with reference to the general classification of soils and distribution of forest-growth. It appeared to me that, with a little preliminary instruction and a reasonable amount of supervision and assistance from Forest Officers, the Surveyors ought to be able to furnish us with information which would form at least a basis for more detailed enquiry and expedite the preparation of Working-Plans. Colonel Doveton doubted whether the professional Surveyors would undertake anything of the kind, and whether anything they might agree to attempt would be of much value.

"I have now had an opportunity of discussing the question with Colonel Wilmer, the officer in charge of the Hoshangabad Forest Survey, and Mr. Thomas, the Deputy Conservator in whose jurisdiction operations will this season be carried on. Colonel Wilmer has no doubt whatever that his men could do what I propose, and has most courteously consented to meet my wishes to the utmost of his ability. His plane-tablers work each within an area of about 20 square miles for the whole season, and must necessarily become intimately acquainted with all the features of the locality. They are all men of trained intelligence and habits of observation, and it is only reasonable to assume that, with a little preliminary instruction from Mr. Thomas and the aid of his Forest Staff, they will be able to give a very good account of the areas covered by their operations."

The following is Colonel Wilmer's memorandum on the system adopted by the Survey Party employed under his orders in Hoshangabad:—

"To carry out the wishes of the Chief Commissioner and Forest Officers, Central Provinces, and after consultations with them, a system of classification of forests and soils was adopted and carried on at the same time as the original detail survey was made, the former by the *colours* of lines used for shading, and the latter by the *direction* of the lines. The classification was shown on tracing cloth by symbols as follows :—

The Forests were divided into five classes, *viz.*:—

1.	Forest where teak abounds without bamboo, ...	*Carmine.*
2.	" " with bamboo, ...	*Blue.*
3.	Miscellaneous forest, ...	*Brown.*
4.	Grass lands, ...	*Green.*
5.	Cultivation, ...	*Yellow.*

Soils were divided into four classes, *viz.* :—

1.	Very good and rich, ...	*Lines drawn*	*vertically.*
2.	Medium, ...	„	*horizontally.*
3.	Very dry, ...	„	*diagonally from N.-W. to S.-E.*
4.	Unproductive, ...	„	*do. from N.-E. to S.-W.*

Each Sub-Surveyor kept an outline trace of his daily work on a piece of tracing cloth, and also made notes of the nature of the soil and class of forests that he met with. At the end of a few days when sufficient detail survey had been completed, he coloured up the portions and marked them with lines according to the fixed symbols. This trace the Sub-Surveyor kept going until his work was done, and it was examined at the same time as the topographical detail. Some differences of opinion were found at the adjoining edges as regards nature of soil, more especially between the 'medium' and 'very dry,' but these were reconciled.

"On compiling the different Plane Table Sections into Standard Sheets it was found that laying colour on to the tracing cloth spoilt it and rendered it opaque. The plan of drawing in the lines in their proper colour and direction was then adopted, and was found to answer all purposes whilst the tracing cloth was kept clear and smooth.

"The extra cost entailed can only be arrived at approximately. For the field work I have allowed that over an area surveyed of 4 miles square or 16 square miles a delay equivalent to the time occupied in surveying half a square mile was entailed owing to the time spent in classification. The season's outturn having been 353 square miles, at a rate of Rs. 180 per square mile, the loss entailed is equivalent to the cost of surveying 11 square miles = Rs. 1,980. The estimate for the mapping and compiling into Standard Sheets can be made more accurately, and it has been found to amount to Rs. 390. This, with the cost of supervision, *viz.*, Rs. 100, makes a total of Rs. 2,740, or Rs. 7 per square mile.

"The fair trace is made over to the Forest Officers.

"The classification of the forests and soils was arranged by Mr. Thomas, Deputy Conservator of Forests, Hoshangabad, and it applies to the forests of Hoshangabad and Betul only. A different classification would probably be required by other Forest Survey parties, and could be arranged for by the respective Forest Officers according to their requirements. But the system of classifying by means of the colours and directions of lines might probably be adopted with advantage."

W. E. D'Arcy.

THE FORESTS OF THE UPPER BURMA RUBY MINES.

READERS of the "Indian Forester" may find the following short description of the Ruby Mines forests interesting. So much has lately been written about the Ruby Mines in all the leading news-

papers that a very few words as to the situation of the Stone tract and its general appearance will suffice as an introduction. This tract is about 80 miles north-east of Mandalay on the border of the Northern Shan States. The usual route to it is by steamer up the Irrawaddy for 100 miles above Mandalay, and then by road, mostly uphill, for 60 miles inland. The march up the road in its present state takes from four to six days, so till the road is considerably improved, the situation of the Ruby Mines will continue to be considered remote.

The country is very hilly. Some of the peaks around Mogôk, the chief settlement of the miners, rise to a height of nearly 8,000 feet. The land is everywhere well watered and is extremely fertile.

The forests are of two distinct types :—

1. The *open Oak and Chestnut* forest, which lies uniformly over the hill ranges from 2,000 feet to an elevation of 5,500 feet and more, according to aspect.
2. The *Evergreen Forest*, which grows from the upper limit of the oak and chestnut forest to the tops of the highest peaks and ridges.

Oak and Chestnut Forest.

The Oak and Chestnut forest, so called from the predominance of these species, begins to appear a little above the teak zone. The changes from the usual moist forest of the plains—the home of pyinkado (*Xylia dolabriformis*) and teak—or, as it may sometimes happen, from dry "Indaing" (*Dipterocarpus tuberculatus* forest), to oak and chestnut, are gradual and hard to trace owing to most of this intermediate stage of forest having been at some not very distant time subjected to "taungya" or hill cultivation. However, many species belonging to the lower forest can be traced amongst the oak and chestnut to a considerable height. Such are *Duabanga sonneratioides*, *Lagerstrœmia Flos-reginæ*, *Terminalia belerica*, *Mallotus philippinensis*, *Careya arborea*, *Adenanthera pavonina*, *Cassia Fistula*, *Phœnix sylvestris*, *Cephalostachyum pergracile*, and many others.

The species characteristic of the oak and chestnut forest, beginning at the lowest elevation and following the order in which the oaks and chestnuts, respectively, occur, are :—*Quercus Helferiana*, *Q. Amherstiana*, *Q. Lindleyana*, *Q. spicata*, *Q. fenestrata*, *Q. Brandisii*, and *Q. serrata*, *Castanopsis indica*, *C. tribuloides*, *C. castanicarpa*, *C. Tungurrut*, and *C. javanica*.

Some of these oaks and two others (*semiserrata* and *glauca*)

mentioned below, have been found to yield wood suitable for cask staves.

Of other species, *Schima* (species unknown) grows in fair proportion, and is a useful timber tree. Species of *Rhus*, *Jasminum*, *Sapindus*, *Callicarpa*, *Artocarpus*, *Ficus*, *Ulmus*, *Morus*, and many other *Urticaceæ*, are common. So are *Miliusa Griffithii*, *Engelhardtia spicata*, *Elæocarpus Griffithii*, a *Michelia* near *M. Champaca*, *Hiptage Madablota*, and *Premna integrifolia*. *Laurineæ* are well represented. *Machilus villosa*, one of the best timber trees of the district, occurs frequently in the higher portions of the forest. *Alseodaphne grandis*, *Helicia erratica*, and other *Helicias* with heavy clusters of fruit are a characteristic feature of the higher and more exposed ridges. *Ternstrœmia japonica* is their constant companion in such situations. *Salix tetrasperma* and *Carpinus viminea* fringe the streams, while *Rhododendron moulmeinensis* (a species that bears large clusters of sweet-scented white flowers) forms thickets in the moist ravines, giving shelter to a few barking deer and jungle fowl, almost the only game to be seen in the forest.

There is not much undergrowth in the above type of forest—a feature in which it is strikingly different from the evergreen forest. Saccharum and other tall coarse grasses come in where taungya cultivation has removed the natural growth.

In the lowest parts of the valleys, at the upper limit of the oak and chestnut forest, open groves of *Quercus glauca* and *semiserrata* (the former sometimes pure), *Schima crenata*, *Prunus Puddum*, *Cephalotaxus Mannii*, odd rhododendrons (*arboreum*), *Olea terniflora* (nearly pure), *Litsœa sebifera*, *Pyrus variolosa*, a subspontaneous crab apple ; and on the streams, *Salix tetrasperma*, hornbeams, and a bush-like *Celastrus* occur. All the larger trees are covered, on the side away from the wind, by ivy and a creeper like the ordinary Virginia creeper. Owing to the violence of the wind in these valleys, orchids and other epiphytes are seldom able to establish themselves on the trees. These park-like bits of forest are peculiar to the large open valleys from 4,000 to 6,000 feet elevation. The undergrowth is light, and consists of flowering weeds like *Melastoma malabathricum*, *Desmodium tiliæfolium*, &c.

Outside the groves of *Quercus glauca* and *semiserrata* the fires sweep over large open tracts every year, keeping down all tree growth. Fortunately a number of hardy shrubs and annuals overrun these blanks and save the soil from being washed away. When it becomes possible to stop the fires, the soil, so protected, will be easy to plant up. The commonest of the shrubs just mentioned are a gigantic thistle, *Sesbania aculeata*, and the common

bracken (*Pteris aquilina*). The bracken is in largest proportion, and forms a peculiar feature of the scenery. Raspberries and blackberries are common wherever the bracken grows.

Colonies of *Pinus Khasya* occur on the slopes of rocky spurs from 5,000 to 6,500 feet.

Evergreen Forest.

The transition from oak and chestnut to evergreen forest is sudden as a rule, but where taungya cultivation has been practised, a band of very open growth intervenes, comprised chiefly of *Bauhinia variegata* and *nervosa*, *Kydia calycina*, *Rhus semialata*, *Phyllanthus nepalensis* and *Emblica*, *Cedrela montana (?)*, *Albizzia stipulata* and *odoratissima*, *Lebbek* and *procera*, *Pithecolobium clypheana*, an *Hibiscus*, *Vernonias*, subspontaneous *Macaranga*, *Erythrina*, and kindred species.

On the skirts of the evergreen forest there are often long stretches of grass land without any trees, except a species of stunted Phyllanthus. These large blanks have probably been caused by fires, but it is possible that they may be natural in some cases, as there often appears to be a stratum of stone too close under the soil to give room for the roots of any but the smallest trees.

The above changes lead from the open oak and chestnut to the *Evergreen Forest*, a type of forest peculiar to the higher ridges of the Ruby Mines. The growth is lofty and dense. It is said to resemble the upper hill forests of Tenasserim, but to possess certain characteristics of its own. The presence of large numbers of climbers, some of immense size, of tree ferns, climbing rattans, and thickets of a small species of bamboo (*Melocanna*), forming a perfect network, gives the forest a semi-tropical appearance. This effect is added to by the dense under-growth of species of *Acanthaceæa*, *Musa*, and a host of herbaceous weeds. The stinging nettle (*Urtica heterophylla*) is very common near paths and open spaces. The extremely moist condition of the air, due to the elevation of the forest, produces a plentiful growth of ferns, begonias, Arums, mosses, and lichens. At all times the forest is gloomy, and, except at the end of the dry season, dripping with moisture.

The principal trees, so far as they have been determined, are :—

An oak, species unknown, several chestnuts, including *Castanea Tungurrut* and *Castanopsis castanicarpa*. Numerous species of *Laurineæ*, such as *Tetranthera monopetalla* (?) and others, *Litsæa sebifera* and *Machilus villosa*; numerous *Ternstrœmias*, as *Camellia caudata*, *Eurya symplocina* and *acuminata*; *Acer laiergicum* and

Acer species nova; Coffea tetrandra; species of *Rhus, Olea; Prunus Puddum* and other large species of *Prunus; Zyziphus glabra, Caragana longispina* (?), *Ficus pyriformis* and other figs, some with aërial roots developed into gigantic stems up to 70 feet high; *Cerbera Odollam, Eugenia Jambolana,* species of *Guttiferæ, Araliaceæ, Euphorbiaceæ, Vaccinium ardisioides, Ligustrum confusum,* and *Cephalotaxus Mannii,* a handsome species of yew.

The above with numerous other genera grow in varying proportion according to elevation. The nature of the forest does not seem to be affected by aspect. On high and steep ridges, where the nature of the soil does not favour other growth, *Rhododendron arboreum,* a showy *Mussænda,* and a small fan palm, flourish almost alone.

The soil both in the oak and chestnut and in the evergreen forest is composed of heavy ferruginous clay and disintegrated limestone, traversed by veins of limestone and gneiss.

The general appearance of the evergreen forest from the outside is unbroken and of a uniform green. This green is so dark that it gives to the main watershed the name of Taung Mè or the Black Mountains. Inside the forest, despite its gloom, there is a great variety of colour due to the variegated foliage and plentiful flowering of a large number of trees.

9th September, 1890. E. M. B.

TREATMENT OF BAMBOO FORESTS.

In the "Forester" for April—June, "S. E.-W." has an interesting note on the management of bamboo forests, and I am surprised that no paper has appeared since giving briefly the method of working the Rauli Block in the Saharanpur forests.

I do not quite understand "S. E.-W.'s" objection to selling a block outright by auction to the highest bidder either at so much a cart-load or per mille, or for a lump sum, reserving the right, if necessary, to sell to supply the wants of the local population.

If his bamboo forests yield 15 to 20 per cent. of his revenue, surely the block or blocks deserve particular care; and if the cuttings were localized to definitely defined coupes and stringent conditions were drawn up as to—

(i).—Mode of cutting.

(ii).—Number of culms to be left in each clump—(I would advise 10).

(iii).—Regularity of cutting, by which I mean that the contractor should be bound down to begin from one end and cut progressively over the whole coupe to facilitate inspection : and a large deposit, say 25 per cent. of his purchase-money, was taken from the contractor, forfeitable upon breach of any of the conditions laid down.

I think he would find that prices and consequently revenue would rise and work be done systematically.

I admit difficulty at first, but this, I think, could be overcome by a judicious combination of the *suaviter in modo* with the *fortiter in re*—probably at first more of the latter.

His coupes could be of any size, dependent upon demand and distribution. A three-year rotation has been found sufficient in Saharanpur, measurements and countings taken yearly showing there has been no diminution in girth or number. But the rotation would necessarily have to be fixed by extent of forest and demand. This method, too, would do away with the necessity of a long and probably more or less complicated price list, and would eventually lessen the work of Range officers. "S. E.-W.'s" last paragraph rather staggers me. I must say, with all due deference, that I have observed without exception that a mixed bamboo forest tends to become a pure one in time, reproduction being next to impossible. Fires would surely increase this tendency.

Of course there are different degrees, so to speak, of mixture ; the more the bamboos, the stronger the tendency for the forest to become pure. The only chance for tree reproduction, and that a very poor one, would be when an extensive gregarious seeding took place, as for the first ten years or so the young bamboo attains no height, but in and about the eleventh year up shoot strong healthy culms, generally to the eventual exclusion and destruction of all other re-growth.

Lastly, are not pure bamboo forests self-protective, humanly speaking, long before 12 or 15 years? I would feel inclined to say—given, of course, perfect protection—8 to 10 years. I hope I have not too rashly rushed into print, but the system I advocate is what I am attempting to put into practice, with what success remains to be seen.

I hope more notes on the subject will be forthcoming to help us. I do not quite understand "Ghati" in the same number. He says : "I have substituted fellings *a blanc étoc* followed by artificial reproduction for the jardinage which I found in force." He then goes on to note the "additional revenue from pasture and fodder which follows."

Does he then allow grazing and grass-cutting, for both of which he says the demand is "enormous," in areas where he hopes for successful natural and artificial regneration?

J. G. F.-M.

"S. E.-W." ON THE TREATMENT OF BAMBOOS.—A REPLY.

REFERRING to "Mavin Kai's" letter in Nos. 10—12 of the "Forester" for 1890, clause iv. of the Working Plan is correctly printed in my original notes. The cutting of immature stems is prohibited, and with proper supervision rarely occurs; thus the exporter has the certainty of finding the whole of the previous year's crop intact when he commences operations, and this certainly induces him to willingly offer large extra payments for the privilege of exporting from bamboo forests where the department has protected the immature crop. The form of pass in use under clause i. is a triplicate form, in which is entered the name of the exporter and the limits of the forest where he can work; one copy is given to the exporter, together with printed rules regulating the cutting, one copy is sent to the Divisional office for information, and one copy remains with the Ranger for reference. With regard to the price list under clause ii., the sale price of bamboos was formerly regulated by girth measurement. This naturally favoured the export of thin stems; the present system is to charge on length measurement only, which favours the cutting of the larger girth classes.

Since writing on this subject, I have had the opportunity of inspecting the bamboo forests of Bundelkhand, where the conditions of climate and soil vary considerably from those obtaining further north, the temperature being higher, the rainfall much less, and the soil poorer and more rocky. In result the bamboo of Bundelkhand does not possess such vivid green colouring as in the moister climate, and suffers much from forest fires, so that there fire-conservancy is evidently a necessity if we wish to preserve and improve the growth. I noticed considerable areas in which nearly every clump had been destroyed by fire, and the rank growth of coarse grass following the annihilation of the bamboo gave every promise of future fires even more intense. In writing of fire-conservancy relatively to bamboo forests, it is, therefore, very evident that local details are all-important. The supposition that the solid variety of the male bamboo is chiefly induced by poverty and dryness of soil was strengthened by inspection of the Bundelkhand bamboo forests, these being exclusively located on the steep, well-drained, and

rocky slopes of these isolated hills and ridges, which are a so-well marked physical feature of this part of the N.-W. P. In the Sub-Himalayan forests the solid variety of bamboo is found on the hot and arid outer slopes, and rarely ever occurs in the cooler also moister valleys; but in Bundelkhand the very large proportion of the bamboo is solid even up to a girth of 8 inches. That well-regulated heavy cuttings result in good crops of new stems also received further proof, for the more inaccessible forests of Bundelkhand showed a marked deficiency in the number of shoots of the year, whilst the overworked accessible portions contained a fair number of immature stems, which, however, more rational treatment would certainly improve.

The haphazard mixture of age-classes was curious, and pointed clearly to the yearly seeding of isolated clumps. The proverbial oldest inhabitant stoutly denied the memory of even a very local general seeding, and apparently in this instance he was to be trusted. It is probable that protection from fire and other injuries and careful cutting will in course of time considerably lengthen the average life of a clump, and that in protected forests the objectionable seeding over large areas will occur more and more seldom; it is, indeed, quite possible that in the future we may be able to regulate to some extent the seeding of bamboos so as to replace exhausted clumps by young growth as a result of natural reproduction. I have now no doubt that in the North-Western Provinces the bamboos from healthy and vigorous clumps arrive at commercial maturity in the second year. The stems are liable to many injuries if left standing longer, many are attacked by borers or destroyed by elephants, and, moreover, it is not at all certain that the lower side-branches of the bamboo do not continue to grow long after the parent stem has hardened; and if this is the case, the difficulty of extraction from the clump must yearly increase enormously. Reliable information on this point would be gratefully received.

It will be most interesting to observe what effect the improvement of the quality of the bamboo will have on the revenue derived from this source in the Central Circle; supposing the demand for bamboo to remain stationary, it is evident that the export of an article of superior size and durability tends to lower the number of stems required by consumers, and in point of fact the numbers exported from this Circle are decreasing yearly, though the almost yearly rise in rates has hitherto resulted in an increase in the total revenue collected.

S. E.-W.

THE EXPLOITATION OF BAMBOO FOREST.

In connection with the recent discussion on the working of bamboo forests, the following notes given to the students of the Imperial Forest School, Dehra Dún, may be found useful.

A great deal of attention has been paid to the subject, but as a rule observation has been confined to what occurs above ground, and the conclusions drawn therefrom have hence not been based on physiological principles. Such conclusions, being deductions only from partial facts, are often misleading, though true enough under certain conditions. For instance, "S. E.-W." has put forth the general statement that continued fire-protection is fatal to the maintenance of bamboos. Though true in some cases, such is not, however, the fact universally: reference to physiology would have saved "S. E.-W." from falling into this error.

What goes on underground among the rhizomes requires much more study than it has hitherto received.

Mode of growth of Bamboos.

On emerging from the seed the bamboo seedling is a simple plant, consisting of a leafy shoot, fibrous roots, and a short, comparatively thick, intermediate portion, from which in the following year the first rhizome is developed. This rhizome at once grows up into a leafy shoot, and from this time forth the plant is a compound one and the formation and growth of the clump begins. In the third year one or more new rhizomes are produced from the "eyes" or underground buds of the original rhizome, and every successive year, until the clump flowers, new rhizomes are similarly produced upon those of the previous year. As a rule, only a few of the eyes develop into rhizomes; but of the rest some may later on push forth under specially favourable conditions, as, for instance, when the existing number of unsprouted rhizomes is insufficient to utilise the entire quantity of constructive materials available in the clump.

According to the abundance of food present and the richness of the soil, one or more of the rhizomes produced upon the same parent rhizome start away at once out of the ground to develop into a leafy shoot (culm). Some of these shoots, owing to insufficient nourishment or accidental destruction, may become aborted after they have begun to develop. Thus aborted, they do not usually die, but their rhizomes, like those which remain dormant, may and often do give out new rhizomes, should accident place them subsequently under sufficiently favourable conditions.

Each successive year the new culms formed are taller and thicker than those of the preceding year, and this constant increase of size continues as long as the maximum dimensions attainable by the species in the given soil and locality have not been reached. After this period, save minor differences in different years due to the varying character of the seasons, the maximum dimensions are maintained until the clump fructifies and dies. It is hardly necessary to add that a culm cannot grow thicker, each part of it, as soon as it is fully formed, being as thick as it will ever be.

Since the rhizome has to form completely first, the culm itself does not appear above ground until some weeks of the growing season are past (in the case of full-sized culms not until towards the middle of the season), and it accomplishes the whole of its growth in 3—5 weeks, before it has put forth any leaves at all. Whence, we may ask ourselves, does it obtain the large amount of formative material necessary for such rapid growth? Having no leaves of its own while this growth is going on, and consisting, as it does, mostly of hard woody tissue, it can itself elaborate but little by means of its green superficial covering. The conclusion is thus inevitable that most of the requisite nourishment comes from the rest of the clump, and especially from those in closest connection with it, *viz.*, (1) the parent culm and (2) that from which this latter has been produced (the grand-parent culm). This conclusion has been amply proved by numerous experiments. If the whole of a clump in full production is cut back, even during the season of repose, when the rhizomes contain their maximum amount of reserve materials, the new growth will not contain a single thick culm, but consist only of a dense mass of switches, proving the insufficiency of the supply of food to produce any larger growth. The falling off is more conspicuous the closer to the ground the clump is cut away, for the numerous branches which high-cut stumps throw out elaborate no inconsiderable quantity of food for the production of new shoots. It will be only gradually and after several years that the clump will again begin to produce full-sized shoots, the shoots of each successive year being bigger than those of the previous year, just as in the case of a clump developed normally from the seedling. This demonstrates another important fact, *viz.*, that the larger the parent culms are, the larger, up to the limits of full size, will be the daughter-shoots. This same fact may be proved in a more direct manner thus:—Cut away all the thick culms by the base leaving only the switchy shoots, and the production of the following season will be entirely switchy; then, on the other hand, cut away everything except 1—3 of the large shoots, and in the

next season's growth there will still be found one or more thick culms.

A culm in its first year possesses but few branches, and hence a very limited leaf-apparatus, and it is not until its third season that it attains its fullest development in branches and foliage. For this reason, and also because the shoots of the year are very insufficiently lignified, a culm in its second season requires for its own use a large part of the food it is able to assimilate, and it is only in the third year that it can spare for the rest of the clump all the constructive materials it elaborates. Being then in almost as close connection with the shoot of the year as the immediate parent (two-season-old) culm itself is, it contributes quite as much towards the growth of the new shoot as this latter does. Hence for the development of the new rhizome and resulting shoot its preservation is not less essential than the preservation of the direct mother culm itself. Indeed, it is a well-established fact that even if this latter is cut away, the daughter-rhizome already produced at its base will nevertheless continue to grow on and develop into a new shoot with the help of constructive materials derived from the grandparent culm.

A clump that has free room for development on every side will go on expanding until the whole of it flowers and dies. On the other hand, in a complete crop, each of the individual trees and clumps composing it can occupy no more space than what is left for it by its immediate neighbours. Hence, as long as this space is not yet completely utilised, a clump will go on expanding and producing new shoots year after year. When, however, there is at last no more room left, further useful growth will be impossible unless some of the existing culms are removed by death or the wood-cutter.

Besides expanding by the production of new shoots along the outside, a clump becomes gradually more and more crowded by the development of new shoots also in the midst of the old ones, some species, which form short rhizomes, being especially given to this tendency. Such tendency will be exaggerated in poor, and particularly in shallow, soils, owing to the elongation of the rhizomes being restricted by the small quantity of food available.

We are now able to understand why the culms of each succeeding year are, barring accidents of season, fires, &c., larger than those of the preceding year until the maximum size of the species in question in the given soil and locality has been reached. As year succeeds year, there is an increasing number of stems to ela-

borate constructive materials for the new season's growth, and the increasing size of the stems thence resulting obviously reacts in the same direction. If at any stage of its growth we restrict the further expansion of the clump by cutting out, as soon as it appears, everything in excess of this limit, the size and number of the shoots will continue practically the same from year to year. If each succeeding year we curtail more and more the spread of the clump, the result will be that the size as well as number of the shoots will go on diminishing every year. What precedes may be stated in the form of an aphorism thus :—Overcut and the production will fall off both in size and number of shoots ; cut out the exact amount of the annual production, and the clump will yield the same results year after year ; give rest or cut out less than the annual sum of production, and the size and number of the shoots will go on increasing from year to year until the maximum figures possible in the given soil and locality have been attained.

Although it can in a general manner be said that the strongest clumps will produce the largest shoots, such a statement is not, however, strictly correct, for a given amount of constructive materials present in a clump may form a single very large shoot or several of only ordinary or even small size. The only true criterion of vigour in any case will always be the aggregate sectional area of all the shoots produced in the year in question measured at about one foot above the soil. Hence shoots of the year which grow singly apart from one another, and thus have each at its disposal all the spare food elaborated by its immediate neighbours of the preceding two or three generations, will be thicker than those which come up close together and divide between them this food.

The age at which a clump begins to produce shoots of marketable dimensions varies very greatly with the species and with the soil. The largest species will of course begin to be productive earliest. For one and the same species the nature of the soil always makes an enormous difference. In a well-manured, well-watered garden soil several generations of culms will come up in a single year, with the result that the time requisite for the attainment of a given size of shoots is shortened in proportion. Thus, whereas out in the forest *Dendrocalamus strictus* takes, under the most favourable conditions, eight years to produce saleable shoots, in a nursery it may reach this stage of growth in its third, and sometimes even in its second, year. As the natural term of life of a clump varies, according to the species, probably from 20 to 50

years, it is evident that for a very considerable term of its existence it remains unproductive.*

Before closing this rapid survey of the mode of growth of bamboos, a peculiarity must be noticed which affects to no little extent the work of the wood-cutter. The bending of the rhizome to grow up vertically upwards is continued in the shoot itself after this latter has come up out of the ground and often until it has attained a considerable length. The result is that the shoot, even if produced quite outside the edge of the clump, bends inwards and enters in amongst the foliage of the shoots of preceding years, so that when it is cut, there is always some difficulty in disengaging it from the interlacing mass of branches and twigs. The difficulty is greatest in the case of shoots which originate in the middle of the clump, and if the clump is at all crowded, some of the shoots inside cannot be taken out except in short lengths.

Resume.—The principal facts discussed in the preceding paragraphs may now with advantage be brought together and briefly stated thus :—

I.—The bamboo plant, from being at first a single individual becomes a compound entity or clump, the clump expanding itself by the production of new shoots. In the open this expansion has no limit, and ends only with the death of the clump, and the number of new shoots follows a steadily increasing series from year to year. In a close forest a similar expansion occurs until the clump has occupied nearly the whole of the space available to it. This is the culminating point; thenceforward the rate of expansion and the number of culms produced each year diminishes, and when all the available space has been occupied, no new growth is possible except in replacement of casualties.

II.—During the ascending phase of expansion the size of the shoots produced in successive years goes on increasing from mere switches to the maximum dimensions attainable by the given species in the given soil and locality; and when these dimensions have been reached, no further improvement is possible.

III.—New culms are produced almost exclusively upon the shoots of the youngest generation with the co-operation principally of the shoots of the immediately preceding generation, so that the removal of older shoots, especially those from the fourth generation backwards, will have no appreciable effect on the size and number of the new shoots. As the amount of new production will be pro-

* This fact also demonstrates the expediency of forcing early productiveness in plantations by putting out only strong nursery plants.

portionate to the amount of foliage, and as the same amount of foliage will be borne by a few properly-spaced culms as by a larger number more crowded together, the thinning out of the oldest and crooked and weakest shoots will have no effect on the vegetation of the clump or the aggregate basal area of the new culms.

IV.—The aggregate basal area of the new culms being the same, their individual size, within the maximum limit attainable by the species under prevailing conditions, will be greater the smaller their number is.

V.—The larger and more vigorous the parent-culms of the two last generations are, the larger will be the new shoots which they will produce.

VI.—New culms keep coming up even in the middle of the clump, so that, saving the case of a few exceptional species which throw out very long runner-like rhizomes, the clump tends to become so overcrowded that the safe extraction of the shoots becomes increasingly difficult, often even impossible, with the advancing age of the clump.

VII.—The same difficulty exists in a measure even with the shoots produced along the outside of the clump, owing to the habit these shoots have of bending up inwards soon after they have come out of the ground and entering the inextricable tangle of interlacing stems and branches.

Mode of exploitation.

The first thing to determine is the age at which a clump may commence to be exploited. Since it is chiefly the last two generations of culms which contribute towards the production of new shoots, it is obvious that exploitation may not commence until the clump contains at least three generations of shoots of the largest size, until, in other words, such shoots have been appearing for at least three consecutive years. To begin to work a clump earlier would inevitably result in arresting its growth and throwing it back for years. In order to avoid all possible risk, it will nearly always be advisable, especially in dry and poor soils, not to touch any clump until large shoots have been appearing in it for full four years running.

The limitation here laid down applies of course only to the exploitation proper, and does not exclude certain preliminary thinning operations made with the object of keeping the clumps sufficiently open and thus giving the individual culms free spreading room both in the air and in the soil, in order to encourage the early formation of large shoots, and thereby curtail the long period of

waiting during which the overcrowded unthinned clump would go on producing an excessive number of mostly small unsaleable culms. These thinnings also prepare the clumps for easy and systematic exploitation.

It may here be said, once for all, that whether we merely thin or carry out the regular exploitations, every shoot that is removed must be cut as near the ground as possible ; the effect of leaving stumps that do not die for years would be exactly the same as if no thinning at all had been effected.

The time for commencing the exploitations having arrived, it is necessary to know how much and what to cut out at each exploitation. Since the exploitations may either be annual or recur at longer intervals of two or more years, we have two distinct cases to consider under this head.

1. *Exploitation annual.*

Theoretically speaking, it should be sufficient to leave standing only the last two generations of shoots, together with whatever else is too thin or too crooked to be marketable. Actually, however, there is no advantage of any kind in sparing crooked or unsound or weakly shoots, and the clumps must in any case be kept open enough for the unhindered appearance of numerous strong new shoots and the easy extraction of produce. Hence, in practice, it is always necessary to remove some at least of the shoots of those two generations,* obtaining the requisite compensation by preserving an equal number of older, healthy, straight and well-spaced shoots that are still in the full vigour of vegetation. The spacing of the culms left must in any case be proportionate to the requirements of the species concerned and the nature of the soil and climate in question.

The main principle to observe from the very beginning in the exploitation of a clump is that while it is still expanding, nothing should be done to check its increasing vigour, and then, when it has attained its maximum development, to keep unimpaired its powers of vegetation. Both objects are fully secured by adhering to the rule laid down in the immediately foregoing paragraph. During the stage of expansion, the number and size of the shoots of successive years forms, as we have seen above, an increasing series, so that the number and size of the shoots preserved in successive years, in following the rule of exploitation laid down, will

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* These shoots will furnish all the requirements of basket-makers, who require only the soft, flexible, imperfectly-lignified culms of the current season.

form a corresponding increasing series, thereby fully providing for the continued expansion and increasing vigour of the clump. Then, when in course of time the clump has attained its maximum development, the average number and size of the shoots of each generation will remain the same from year to year, and thus the quantity removed each year will be an exact measure of the annual production and the maintenance of the equivalent of the last two generations of shoots will guarantee a sustained yield.

As it is often impossible to recognise with certainty all the shoots of the last but one generation, it will be sufficiently safe in practice, for the purpose of ascertaining the number of shoots to be left in the clump at the successive exploitations, to take double the number of the current year's shoots.

In the foregoing paragraphs it has been assumed that the clumps to be exploited are taken in hand from the earliest years; but actually the mass of our bamboo forests are not or cannot be brought under systematic culture until they have been already worked for many years, or at least have been for a long time in full production. In the case of such forests, the first thing to be done is to bring about a proper spacing of the productive culms, always an expensive and laborious operation requiring to be effected by the agency of the owner of the forest, but one which cannot be dispensed with if exploitation on any scale is to be carried on; it is only when the clumps have been thinned out properly that they will begin to produce up to their full capability, and will be safe against mutilation whenever any shoot has to be taken out. The principles to be observed here, in the thinning as well as in all subsequent operations, are the same as those already prescribed above. If a clump has been overcut, they will enable it, without necessitating a preliminary period of rest and relinquishment of revenue, to acquire the desired increase of vigour and power of expansion, just as in the case of a young clump that has not yet reached its maximum development; and if, on the other hand, the clump has not been exploited up to its actual capacity, their immediate effect will be to at once render available a mass of produce hitherto remaining unutilised, and to place the clump in the best possible conditions for thenceforward yielding the largest and most useful production of which it is capable.

Every bamboo-cutter should be provided with a stiff narrow-bladed saw, besides the usual light one-hand axe. The saw will serve to cut down close to the ground the countless numbers of shoots which cannot be reached with the axe, and without it it will be impossible to thin out overcrowded clumps.

Annually recurring exploitation requires competent workmen honestly and strictly supervised, and, therefore, in most cases, necessitates departmental agency. Nevertheless, if local labour is abundant and competition is keen, it will be possible to dispense with departmental working by adopting a system of licensing picked men and allowing only these to be employed in the bamboo exploitation: the fear of forfeiting their license will effectually compel the men to work in accordance with the prescribed rules.

Annually recurring exploitation will obtain from a bamboo forest its highest utility; it will injure the clumps least, it will yield the largest outturn, and it will furnish the greatest number of large-sized shoots.

2. *Exploitation recurring at a fixed interval of several years.*

Despite the immense superiority of well-directed annually recurring exploitations, the method has not received anything like the attention and consideration it deserves, and the restrictions and conditions it imposes have led many foresters to prefer longer intervals than that of a single year between the successive exploitations. In adopting these long intervals, the essence of every method, whatever the detailed procedure in any particular case might be, is to preserve only the shoots of the current year (these being easily recognised by the least experienced), and, in order to compensate for the small number of parent shoots left, to give to the clumps a sufficient length of time in which to recover from the overcutting to which they are subjected at each exploitation. Thus the question to be decided in each case resolves itself into determining the intervals at which the exploitations should recur, that is to say, the length of the rotation.

A rest of only two years would seldom suffice for the complete recovery of the overcut clumps, unless indeed the demand was considerably under the amount of the annual production. As far as can be judged from present experience, a third year of rest would be ample to restore the clumps to their normal vigour and rate of production. A longer period of rest than one of three years is not permissible in view of the overcrowding that must inevitably follow, with its highly undesirable consequences.*

* The practice has sometimes been adopted of allowing cutting for two years running with only a single year of rest before beginning work again, and in order to prevent the entire disappearance of the youngest generation of shoots, these are priced higher than older shoots. Such a system is, however, only an ingenious device for increasing the revenue at the expense of the production, while making a pretence of aiming at conservation and scientific culture.

As said above, the essence of every system of exploitation at longer intervals than a single year is to spare only the shoots of the youngest generation. As these may come up irregularly, their preservation alone can never guarantee an effective distribution of the shoots in each clump or the securing of vigorous and healthy parents for the coming generation. Moreover, if a clump is weak or has not, from some accidental cause, produced many shoots during the past season, the removal of all the larger shoots but these last must have the effect either of making it still weaker or of preventing it from gaining further vigour. A better plan would hence be to preserve in each clump a certain fixed number of shoots, and to select these from amongst the older generations of shoots if the full number of desirable and properly spaced shoots cannot be found amongst the youngest generation. In following this procedure, clumps which do not contain more than the fixed number of shoots to be left will not be touched at all, and the work of the cutter can be at once checked by the mere counting of the shoots left standing.

Exploitation at longer intervals than a single year is attended with several capital disadvantages, the principal of which are absolute impossibility of keeping the clumps properly thinned out and withdrawal of a very considerable portion of the productive area from exploitation ; hence reduced yield, inferior size of the shoots, difficult extraction, and heavy damage in exploitation. Although the system has many powerful advocates, and is also very extensively practised, its necessity has yet to be justified. If the demand is insignificant in comparison with the annual production, the principle of giving rest becomes entirely redundant, and if, on the other hand, the demand is large enough to require careful conservancy and working, prices will always be high enough to pay for the careful style of cutting required by the system of annual exploitation. Moreover, in this latter case, exploitation at longer intervals than one year must mean heavy overcutting in the open areas.

SEEDING OF THE *DENDROCALAMUS STRICTUS.*

In a particularly hot valley in North Arcot in the Chandragiri Forests, where the *Dendrocalamus strictus is almost pure, this* bamboo is seeding gregariously. After a careful inspection I did not find a clump which was not seeding.

The year has been particularly dry, and the cutting has for years

been atrociously done; in most cases the whole clump has been cut over 5 feet or so from the ground. The seeding, however, began before the dryness of the year could make itself felt, and clumps which, from their inaccessibility, have hardly been touched, are also seeding.

In the south of the district, on the dry lower slopes of the Javadis, the same bamboo is seeding sporadically, as it has done for years. Here too the cutting has been bad, but, owing to the supply being much in excess of the demand, not to the same extent as in the first mentioned area.

J. G. F.-M.

AN AUTHENTIC CASE OF A FOREST FIRE CAUSED BY LIGHTNING.

THE readers of the "Indian Forester" will be interested to learn an authentic case of a forest fire caused by lightning, which occurred last April in the Alapelli forests of the Chanda District, Central Provinces. During a heavy thunderstorm a large teak tree was struck in the Mirkalu reserve, which, it is hardly necessary to say, is protected from fire. The lightning current first struck an upright branch and then ran down the stem setting it on fire. The tree was shivered to pieces, large fragments being scattered over long distances. The storm being accompanied with but little rain, the grass and dry leaves round the burning tree were set ablaze. As this unfortunately occurred in the middle of the night, more than 80 acres were burnt before my establishment could reach the spot and extinguish the fire. It is not often that one hears of a forest fire caused by lightning, and it was my good or evil fortune, whichever you will, that made me a spectator of so rare an occurrence.

A. E. LOWRIE.

THE BEAVER.

In 1874 the Marquis of Bute having obtained four beavers, caused a space of from three to four acres in extent to be enclosed in the wood between Meikle Kilchattan and Drumreach, and placed them there. These not succeeding, his lordship, on 6th January, 1875, obtained seven others. Of these, four succeeded so well that in 1878 I was certain of sixteen being alive, which makes an average increase of four each season. There is a further increase this season, but to what extent I cannot say.

Arriving as they did in midwinter, these little animals, I can assure you, had a pretty hard time of it. However, after a few days' rest, having viewed the situation, they set vigorously to work to make themselves comfortable, and began to construct a dam by forming a dyke or embankment across a small moorland stream, running through the enclosure; at the same time they commenced to build a house to live in.

The materials of which the dyke is constructed are wood, grass, mud, and a few stones which are used for the purpose of keeping the grass and smaller pieces of wood in their place until more is built on the top of them. They have continued raising this embankment to a certain extent every year, until it has now attained the following dimensions, *viz.*, length, 70 feet; height in the deepest part, fully 8 feet; breadth of base at deepest part, from 15 to 20 feet, sloped inside, not straight across, but finely arched against the stream, so that it may the more easily resist the great pressure of water which it has to bear—perfectly level, so that when a *spate* of water comes down it may run evenly over the top from side to side. So substantially have they built it that no material damage has occurred to it from all the floods that have passed over it. They use a number of the larger pieces of wood as props, by fixing the thick end into the ground and the small end on the top, then build on the top of these, so as to fix them firmly. It would require to be seen to appreciate the great skill displayed in its construction, as I think it would tax the

energies of a Bateman or a Gale to make a better with the same materials. If any damage does occur, they immediately find it out and repair it. I have seen them swim along the edge of the embankment, carefully examining it to ascertain the part most needful of repairs, then go to work with a will to rectify it. The dam is now 78 yards long of still water.

Besides the dam already mentioned, upon which they bestow great care in its construction, owing to their house being built in it, they have seven others, some larger, some smaller; one of them having an embankment 105 feet long and an average depth of 3 feet. These serve as places of refuge if the beavers are disturbed when out roaming about in quest of food or felling the trees, also as a waterway for conveying their food, when storing it for winter.

In the construction of their dwelling the same kind of materials are used. As to how they have built it: you must understand that for a considerable distance along one side of the stream or burn the ground rises in a steep bank; but about 20 yards above, where they began to build the embankment for the dam, there was a small level spot which they selected. Then at the bottom of the water they burrowed in 3 or 4 feet, rose up 8 or 10 inches, scooped out a space large enough to hold themselves, broke a hole in the surface about 6 inches in diameter, then began to cover it over with sticks, grass, and a few stones, always keeping it open in the centre by placing a few sticks perpendicularly, so as to act as a ventilator, and as the water rose in the dam and the family increased they continued to build and enlarge the house, cutting their way up and forming their chamber or chambers inside until it has now attained the following dimensions at the surface of the water (which is here about 4 feet deep), *viz.*, height about 5 feet, length and breadth about 9 feet, having a door at both sides placed at the bottom of the water so as to prevent their natural enemies from following them, chief among which is the wolverine, although happily for both them and us there are none of these here to disturb them.

It is out of the water that they take the materials with which they build their house. Were the sides of the house perpendicular they could not land; to obviate that difficulty they have built a slip from 2 to 3 feet broad at its base, except where the doors are, so that they can land easily, and if they wish to enlarge the house they have got the foundation ready. To secure themselves against the winter storms, they commence about the middle of September, and give their house a coat of mud all over. It is with the mouth and forefeet, which are formed more like hands than feet, that

they convey the materials of which their embankment and house are made. They do not use their tail, as was at one time said, for plastering on the mud, but their forefeet, with which they very carefully stow it in among the sticks. As to what they use for a bed to lie on, it is wood shavings, which they prepare in the following manner :—After using the bark for food, they place the stick on end, holding it with both feet a bit apart ; then with their teeth pare it down into fine shavings. They are very cleanly in their habits, as they often clean out their house, not casting away the refuse, but using it either on the top of the house, or the embankment of the dam to patch up a hole.

Their food in winter consists wholly of the bark of trees ; had they a choice, I have no hesitation in saying they would prefer the willow and poplar. These not growing in the enclosure, they had just to adapt themselves to circumstances, and take a share of what trees they could get, consisting of oak, plane trees, elm, thorn, hazel, Scotch fir, and larch. Of the hardwoods, they seem to prefer elm to the plane, then oak, of which they eat sparingly. Of the firs, the Scotch has the preference ; as for the larch they did not touch it till early in 1878, since which time they have taken to it very well. As for the alder and spruce fir, they eat almost nothing of them. Along with all these, we have always given them a supply of willow. In summer they eat freely of the common bracken, likewise grass, and young shoots of every description growing in the place. In autumn they grub up and feed upon roots, chief among which is the tormentil *(Potentilla tormentilla)*, better known to the Scotch people as "tormentil root," and the young tender shoots of the common spurts before they appear above ground, at the same time cutting down a tree now and again and feeding on the bark.

As to the tree-felling it is all done at night ; the number which they have cut down amounts now to 187 trees from 5 feet in circumference downwards. These are all forest trees, besides a great many smaller bushes. Before cutting down a tree, they mark it all round at the height at which they wish to cut it. They begin to cut at the opposite side to which they intend the tree should fall, invariably making it fall with the top to the water. Where they grow near enough, they make them fall across the stream or dam, causing many to suppose that they are so placed to form a bridge, whereby they may cross from one side of the water to another. They do not require a bridge, they can swim, and rather than cross over a prostrate tree they dive under it. My impression is they are so placed to break the current of the water when

the stream is flooded ; also, if convenient, they take advantage of building a dam where some of the trees lie across the water. Those lying across in their principal dam are utilized in storing up their winter food, these stores being built on the upper side of the trees, so that they cannot be swept away with the winter floods.

When cutting the trees they use their teeth, on the same principle that the forester does an axe, always keeping plenty open space, so that they can cut past the centre of the tree on one side before beginning on the other. It is in the latter end of autumn they commence to cut down trees for winter food. Having cut them down, they speedily strip off the branches, cutting them into lengths to suit their strength for dragging them away to the dam, where they store them in different places near their house, so that they may have sufficient food, although the dam may be frozen over, or the ground covered with snow. What is left of the trunks of the trees that they cannot drag away, they feed on at leisure, eating the bark.

Besides the work above ground, which I have tried to describe, they have done a great amount of underground work, such as cutting channels in their dams and making burrows. These burrows they make by cutting a road from the middle of the dam for several yards into the dry ground, where they scoop out a dome-shaped burrow from 8 to 10 inches above the level of the road, then cut a hole through the surface and cover it over with sticks and grass so as to act as a ventilator. Here they live and feed in security and contentment. Some of the roads to these burrows are from 15 to 20 yards long, and so level that the water follows them in the whole length.

As to the time they bring forth their young, from my own knowledge I cannot say. I have seen it stated to be January, and also the beginning of May. I can say nothing against that, judging from the size of the young when I first saw them in the second week of June, the oldest litter being about the size of a full-grown rabbit, and the youngest not half that size.

From careful observations I have good reasons for believing they have only one at a birth. One thing I am certain of, they have two litters in the season. Beavers are a class of animals that are very timid, their sight, scent, and hearing very keen, so much so that it is with great caution they can be approached near enough to see what they are doing. They are under cover all day from seven o'clock in the morning till seven in the evening. When one comes out, it floats on the surface of the water, carefully surveying the whole scene around, sniffing the air, and if no danger is

apprehended it dives and disappears. In two or three minutes a number of the colony begin to appear and disperse themselves, some to swim and sport about in the dam, while others go in quest of food. If one of them espies danger it strikes one sharp, loud stroke on the water with its tail, when all of them that are out come tumbling in to the dam and disappear.

I have seen them wrestle in playfulness and fight in anger, and also when the mother was feeding and the young one sporting about in the dam, I have seen it go and begin to tease her, when, if she did not wish to be troubled with it, she would strike and shake it, and pitch it from her in the dam. They will allow of no laziness in any member of the colony! If any such there be, they are beaten and driven out to live as best they may. These so driven out generally roam about, making a burrow here and there, where they live for a few months and die.—*J. S. Black* in *Timber Trades Journal.*

MEMORANDUM BY DR. H. WARTH ON THE PREPARATION OF KATH OR PALE CATECHU.

*Dated December, 1890.**

IN Dr. Watt's Dictionary of the Economic Products of India we find it stated that the merits and the preparation of *kath* deserve to be thoroughly investigated. As I have had occasion to study the subject and to make experiments, it may be useful to record the following facts.

The *kath* of the North-West Provinces which is used with pân, and the catechu of Burma which is exported to Europe as a dye-stuff, are both prepared from the wood of *Acacia Catechu.* The *kath* is in its purest state chiefly catechin, a crystallizing substance nearly insoluble in cold water. The catechu is chiefly catechu tannin, a substance soluble in cold water and not crystallizing, but some catechin is usually mixed up with it. The difference between *kath* and catechu is partly due to the methods of manufacture, partly to the difference in the trees.

The trees in Burma differ from those of the North-West Provinces, and in each place there are two kinds of trees, No. 1 and No. 2, although of exactly the same species. Trees No. 2 have white spots in the wood, caused by a white substance stored up in cylindrical masses half a millimetre thick and ten millimetres long. Trees No. 1 have no white spots. Trees with spots yield an extract richer in catechin, and both kinds of trees in the North-West Provinces yield more catechin than the corresponding kinds in Burma.

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* The substance of this Memorandum has already appeared in the two papers from Dr. Warth, which we published in the October-December Number of Vol. XVI. We, however, print this paper also, and heartily congratulate Dr. Warth on the successful result of his laborious researches and the high encomiums he has earned for them from the Secretary of State, who has desired that "the widest circulation should be given to this paper in India."—[ED.]

I found the following proportions of catechin in the total extract :—

	Catechin.
Burma, No. 1, ...	14 per cent.
" " 2 (spotted), ...	30 "
North-West Provinces, No. 1, ...	36 "
" " " 2 (spotted), ...	40 "

The greatest amount of extract obtained from each kind of wood was as follows :—

	Extract.
Burma, No. 1, ...	17 per cent.
" " 2 (spotted), ...	18 "
North-West Provinces, No. 1, ...	14 "
" " " 2 (spotted), ...	24 "

The greatest amount of catechin obtainable from these woods is accordingly as follows :—

	Catechin.
Burma, No. 1, ...	2 per cent.
" " 2 (spotted), ...	5 "
North-West Provinces, No. 1, ...	5 "
" " " 2 (spotted), ...	9 "

Such a great proportion of catechin in the spotted wood of the North-Western Provinces explains that *kath* manufacture is at home there. Moreover, the local *kath* makers are reported to refuse as unfit all trees which do not contain white spots, so that the trees No. 1 become wasted in the forests.

I determined the catechin by direct separation as follows. About two ounces of the wood reduced to thin shavings were boiled, with twenty times their weight of water, for half an hour. The extract was separated from the wood by repeated settlement, and reduced in bulk on the water bath until it just began to thicken and contained by estimate 6 per cent. of catechin. It was then left to stand in a cool place for five days for the separation of the catechin. Once the catechin had separated, the liquid could again be diluted with cold water for the purpose of filtering. The filtered and roughly washed catechin was dried at ordinary temperature, and weighed in a thoroughly air-dry condition.

The high degree of concentration and the long standing are required because the catechin separates with difficulty out of an extract which contains so much catechu tannin. Once the bulk of the tannin is separated, the catechin may be dissolved in much more water, and *it will separate immediately on cooling ;* but the catechin is at all times a delicate substance, which changes with

water slowly into a soluble substance and is thus lost. The drying of the moist catechin must take place at a low temperature, as heat at once destroys the microscopic crystals.

The manufacture of *kath*, or raw catechin, is carried on in the forests with very primitive appliances. The filtering is done through layers of sand, and much sand becomes mixed up with the *kath*. The drying is performed in the open air.

The people say that they possess a manufacturing secret; but there seems no need for one, unless their secret consists in the mixing of some finished catechin with the thick liquid, which sometimes promotes the separation of the new catechin. Anyhow, I made out of the 50 lbs. of *Acacia Catechu*, No. 1 from the North-West Provinces, nearly 2 lbs. of pure catechin, and it is from this wood that the *kath* makers of the North-West Provinces declared themselves incapable of making *kath*. For filtering larger quantities of catechin, I found the filtering press an excellent expedient. The pressed catechin dried in a few days from simple exposure to the air, and once dried the catechin is a very durable substance.

Contact with iron must be scrupulously avoided during the extraction of catechin. With catechu or cutch contact with iron is of no consequence, and the reports mention iron caldrons in use for the final boiling down of the cutch in Burma.

The preparation of cutch or catechu is of course simpler than that of *kath*, because nothing but watery extraction of the wood is required and subsequent boiling down of the extract.

After a certain degree of concentration, a skin forms over the surface of the hot liquid, and constant stirring for hours is required to effect the final desiccation. This long stirring process is also mentioned, but not explained, in the descriptions of the Burmese catechu extraction. In modern dye-extraction works, the stirring would be avoided by the use of vacuum pans.

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THE RAVAGES OF *LIPARIS MONACHA*, THE "NUN," IN THE SPRUCE FORESTS OF SOUTHERN GERMANY, IN 1890.

North of the lake of Constance is situated a large area of low hills commonly regarded as the remains of the moraines deposited by the gigantic glaciers, which during the ice period, extended from the Alps a long distance northward. The prevailing deposits are masses of clay, loam and sand with pieces of limestone, granite shale and other rocks, the result of glacial action upon the Alps. Owing to the great variety of its constituent elements, the soil is extremely rich and the forest growth in this region is extremely luxuriant. Foremost are the magnificent forests of Salem in the Grand Duchy of Baden, where the timber production of the beech almost equals that of the spruce in the Black Forest; and in the Kingdom of Wurttemberg the forest of Weingarten, situated 11 miles north of the lake, near the Friedrichshafen-Ulm railway line. This range, one of the twelve Government ranges under the Forstmeister at Weingarten, is for the greater part, stocked with spruce and also contains a certain area of mixed wood, of spruce, scotch pine and beech. An area of 6,685 acres here has a mean annual yield of 100 cubic feet per acre, under a 100 year's rotation. Formerly the forest was regenerated by natural means, but in 1839-40, 1,230 acres were devastated by the "Nun," the whole of the trees were cut down and the area was re-stocked by sowing, between 1841 and 1846. Since that time clear cutting and planting gradually became the rule, and natural reproduction the exception, in this forest range.

In the case of spruce, five year old plants are used at the rate of 2,200 plants per acre. Periodical thinnings are commenced when the woods are 30 years old. The State forest range of Weingarten forms part of the large, so called, Imperial forest (Reichswald) of Altdorf, over which, in the Middle Ages, the German Emperor had certain rights, which gradually became vested in the neighbouring large landed proprietors and the town of Weingarten. The final partition of this forest among those who had an interest in it, was effected in 1834.

Parts of this and of the neighbouring forests have at various times been devastated by the " Nun." As already mentioned, in 1839-40, 1230 acres belonging to the State were eaten completely bare, the trees were cut and upwards of 5,650,000 cubic feet of timber 40-80 years old had to be sold all at once and were sold at a considerable loss. In the same year, a forest near Hohentengen belonging to a large landowner in the same part of the country, about 25 miles north west of Weingarten, was also attacked by the Nun and the timber was cut and sold. The same thing was ordered to be done by Government in a considerable area of adjoining forests, belonging to a number of small proprietors. The orders were not, however, carried out, and after the lapse of 3 years the trees had completely recovered and had reclothed themselves with foliage. In 1856, a large area of commercial and private forests in the same part of the country was devastated by the Nun, extensive woods being eaten completely bare. Acting upon the experience gained in 1840, the trees were not cut and they recovered completely, so that 3-4 years later, no trace of the damage could be discovered.

In 1889 the insect attacked a large private forest situated south of Hohentengen. The timber was not cut and in the autumn of 1890 the trees to all appearance were in good condition. This was the forerunner of the terrible damage done in 1890, when in an adjoining private forest 600 acres were attacked and not less than 3,580 acres in the Weingarten State forest range. Of this area 617 acres are completely bare, 493 acres severely attacked and 2,471 lightly so.

Before giving particulars concerning this gigantic damage, it will be well to state the outlines of the life history of this insect. *Liparis Monacha* belongs to the night moths, the perfect insect is about one inch long, wings white with black wavy lines across, the body of a dull red colour with black bands. Towards the end of August the female lays its eggs in cracks and fissures of the bark. The number laid by each female is about 150, but they are frequently deposited in small heaps of from 20 to 30. They are attached by a kind of glue to the surface upon which they are deposited, but the glue is not very plentiful, hence they are safest on barks with a rough surface, the insect inserting its egg-tube deep into cracks and fissures. During the winter, from September until spring, a period of nine months, the tiny caterpillars which are almost fully developed, remain dormant in the egg. Towards the end of April, or, when the weather is cold, early in May, the caterpillars break the shell of the egg, and for some time (3-5 days) they remain together in patches, called mirrors (Spiegel) because they have a shining, almost brilliant, appearance. In that stage they can be readily distinguished and much good may be done by destroying them. Their movements, however, entirely depend upon the state

of the weather: when it is very fine, the tiny caterpillars not rarely begin to disperse the day after they have left their eggs.

While young, until they have attained about half their size, the caterpillars spin fine threads, and by means of these threads they secure their position while feeding. They are also supposed to protect themselves against birds or other insects, by letting themselves down from the tree by the aid of their thread. When the crowns of the trees, in which they are at work, are shaken by the wind, they let themselves down in the same manner by their threads, and when in a stiff breeze the threads tear asunder, the caterpillars are often blown long distances into other portions of the forest.

Older caterpillars also, which no longer spin a web, even such as are full grown, let themselves fall down from the trees, whenever they are disturbed by wind or other causes. On cold and rainy days the caterpillars come down in masses in order to conceal themselves under moss and lichens and in the fissures of the bark on the lower part of the stem, and on the ground under moss and leaves. They also descend from trees which they have eaten bare.

In this manner it happens, that the descending caterpillars fall upon advance growth, which stands under the old trees and is always eaten bare, where the "Nun" has been at work on the old trees. It also is of common occurrence, that caterpillars are blown by the wind into masses of younger wood, which adjoin the old trees on which the eggs had been deposited. All caterpillars that have come upon the ground, on account of bad weather or because they had been blown down by the wind or disturbed, or because they had cleared the trees on which they had been feeding, endeavour, if not yet full grown, to ascend trees not yet attacked. Where all trees in the immediate vicinity have been bared, the caterpillars travel short distances in search of food, and in such cases it has been found feasible to collect them in ditches with steep sides, or to protect a wood as yet untouched by surrounding it with a ring of poles laid on the ground, the bark peeled off, and the poles coated with a mixture of tar and glue. These protective measures, however, are often rendered nugatory by the action of the wind, blowing caterpillars on to adjoining woods, especially while young, and still spinning their threads. When all trees over a considerable area have been eaten bare, the caterpillars which have come down upon the ground in the manner just described, perish from starvation, often in enormous numbers. Thus in the Ebersberg forest of Bavaria, in the summer of 1890, huge heaps of dead and perishing caterpillars covered the ground under the trees, the number per tree being estimated at from 20,000 to 50,000. Whether the caterpillars are feeding on the tree on which the eggs had been deposited, or whether they are on one which they had subsequently

ascended, they feed upward as a rule, commencing in the lower part of the crown and progressing towards the top of the tree. The caterpillar dislikes wind, and thus it often happens, that in woods which have not been completely denuded, the lower branches, in fact the whole crown, is bare, while the very top of the tree has been spared. This happens particularly in the case of dominating trees, the tops of which stand out above the general canopy of the wood.

About the end of June or later, if the hatching of the eggs had been delayed by bad weather in spring, the caterpillar changes into the chrysalis stage. For that purpose *the full* grown caterpillar settles in fissures of the bark or under moss and lichens on the stem. Sometimes the chrysalis is found attached to the leaves or branches of the tree and on advance growth. The insect remains in the chrysalis stage for about a fortnight. A few moths make their appearance in the beginning of July, sooner or later, according to the time when the caterpillars were hatched in spring. Gradually, the number of moths increases, until, in the second half of July, the great flight begins, which lasts until the second week in August. Toward the end of that Month only a few moths are to be seen. The moths like shade and they have a tendency to leave woods which have been eaten bare and congregate in portions which have not yet been touched.

A moth which, in some respects is analogous to the "Nun," is Gastropacha Pini, the scotch pine caterpillar, which used formerly to be dreaded as the greatest enemy of scotch pine in Germany. Those officers who were with me in the forests of the Grand Duchy of Hesse Darmstadt, in August 1888, may recollect the area of Pine forest at the foot of the Melibocus, in the highest point of the Odenwald, devastated by that caterpillar. Its mode of life is different from that of *Liparis Monacha.* The eggs are laid in August, the caterpillars, which come out in September or October, descend from the trees where they have been feeding, before the severe cold commences and spend the winter months ensconced in moss or dry needles at the foot of the trees. In spring, aroused by the warmth, they ascend the trees and eat them bare in no time. *Thus the life history of this insect affords a welcome* handle to the Forester in his attempt to do battle against it. Search is made in winter after the caterpillars are buried in the ground under the trees, and where more than a certain number are found, rings of mixed tar and glue are applied to the stem, which prevent the caterpillars from ascending the tree. In this manner thousand of square miles of scotch pine forests in Germany have been protected and the pine moth has now been well-nigh exterminated. So simple and effective a proceeding is not possible in the case of the "Nun" and, as a matter of fact, the task of doing battle against this pest, and of preventing or even only diminishing its ravages, is one of extraordinary difficulty.

After this digression we will return to the Weingarten forest range. The outer portions, where the woods adjoin meadows and open fields, were untouched, but as we approached the heart of the forest, the foliage of the spruce was remarkably thin and soon we found ourselves in the midst of woods which were almost completely bare. The caterpillar had, however, confined its ravages to mature or nearly mature wood and to pole wood of advanced age. All advance growth under the shade of the older trees had been eaten completely bare, but compartments stocked with young wood even where they were entirely surrounded by old wood, had escaped. The old trees were not all entirely leafless, the tops of most trees had a few shoots left clothed with needles. This was particularly the case in exceptionally tall trees, the tops of which stand out from the rest of the canopy. Again, there was a marked difference between the tops of hillocks and ridges, where the spruce had suffered much less, and hollows and other low sheltered places, where the destruction was complete. The Nun is polyphagous, and accordingly we found numerous beech and other broad leaved trees scattered among the spruce, clothed with young, tender foliage, at the time of our visit (in October), the trees having been eaten bare, in some cases twice, during the summer. The Scotch pine, which is mixed with spruce in places, was attacked to a much less degree than the spruce. Mixed wood of beech, scotch pine and spruce. which occupy several compartments in this beautiful forest, had almost entirely escaped.

Thus the ravages of the Nun in the Altdorf forest of Oberschwaben present several remarkable features, most of which, it will have been noticed, are intimately connected with the life history of the insect. The moth seeks the shade and the caterpillar dislikes wind. This, to some extent, explains why the ravages of the insect had been confined to the inner parts of the forest and why the tops of hills and ridges had escaped. The most remarkable feature, however, is that in this particular locality, the insect had multiplied to such an extent, while the damage done to others of the extensive spruce forests in this part of Germany was insignificant. The production of millions of caterpillars, which causes devastations like that here described, is only possible under the operation of specially favourable climatic conditions. Of these the most important, probably, is a succession of fine evenly warm springs, not interrupted by periods of cold, wet weather. As long as the young insect is in the egg and is thus protected by its shell, it is not affected by frost or by wet. But when the eggs are hatched after the first warm days of spring, the young caterpillars are helpless. At that time they are generally exceedingly sensitive, and are apt to perish wholesale, if a period of cold, wet weather sets in*. The end of April, therefore, and the first

* Some remarkable exceptions to this rule have, however, been reported, the young brood of the "Nun" having stood very severe weather in spring without being killed by it.

fortnight of May, may probably be regarded as one of the most critical times in the life of the insect. Its multiplication, however, is apt to be arrested not only by unfavourable weather, but also by the multiplication of its enemies, such as several species of fungus, flies called *Tachina* and in some cases, of ichneumons, the larva of which lives in the caterpillar. The conditions which favour the development of these most useful enemies of the Nun, have not yet been specially studied, but it is probable that they are different from those which favour the development of *Liparis Monacha.* In any case, it may be said, that the extraordinary multiplication of the "Nun," such as that which took place last year in the Weingarten Government forest, is chiefly due to certain climatic circumstances, which favour its development, as well as to others which have prevented the development on a large scale of its enemies.

Now it is very remarkable, that these circumstances should have combined, in this locality, to produce this effect, not in 1889 and 1890 only, but equally so in 1839-40 and in 1856. Hence it does not seem unreasonable to suppose, that the effect of certain climatic conditions upon the development of the insect shows itself in a more marked manner in certain localities than in others. The localities where, in this part of Germany, the spruce forests have been ravaged by the Nun in 1889-40, 1856 and 1889-90, are comprised within a tract of country 25 miles across, and here again, the Weingarten forest range has been exposed twice, in 1839-40 and in 1890, to a devastation so severe, that compared with it, the damage done in the other forest districts was insignificant. And it may at once be mentioned, that that part of the Weingarten Range which has been thus devastated is situated upon undulating plateau, about 2,000 ft. above the sea, exceedingly dry, with hardly any springs.

The second locality, where the ravages of the Nun have been extensive last year, was in the Ebersberg forest, situated in the Province of Oberbayern, 20 miles east of Munich and 112 miles east of Weingarten. The locality is level, at an elevation of 1700 feet and like this Weingarten Forest, exceedingly dry. There is here a compact area of 16,510 acres all densely stocked forest, almost pure spruce, with a mixture of Scotch pine in places and a few scattered beech everywhere, the proof that formerly this was a mixed forest. The woods are well stocked, but the soil is much less rich than the boulder clay of Weingarten. Moreover, the forest had for centuries been maintained as a huge game park and accordingly thinnings were made sparingly, the young growth, poles and trees, grow up in a crowded condition and consequently grow very slowly. Hence the timber proportion per acre is only about one half of what it is in the Weingarten range, say 50 cub. ft. per acre per annum. Thus, as regards the dry soil and general conditions of climate, circumstances are similar to those at

Weingarten. But the densely crowded growing stock has rendered this locality even more favorable for the multiplication of the insect which, as explained, in the moth stage, as well as in that of the caterpillar, seeks shade and shelter, avoiding light, open woods.

As a matter of fact the devastation here has been quite unparalleled. Here, as in Weingarten, the edges of the forest, where it adjoins the open country, were untouched, but in the interior 12,100 acres were severely attacked and in this a compact area of 4,700 acres was completely bare. Not a vestige of a leaf was left on the trees. Nor was the damage here confined to older trees, but extensive areas stocked with young wood were likewise completely bare. The sight of this desolation was appalling, and the contrast between the interminable leafless area in the centre and the green wood near the edge of the forest was extremely striking. Scotch pine is found scattered among the spruce, and here, as in Weingarten, the scotch pine had not been much attacked. Some compartments, with a large proportion of scotch pine, presented a marked contrast to the bared woods surrounding them. Under these circumstances, there was no alternative but to cut down all the timber which had been bared by the caterpillar. In Weingarten, what under the circumstances appeared as the correct policy, was followed, *viz.*—the regular annual yield or rather a little more than the regular yield, 700,000 cubic feet were cut, not in the compartments provided by the working plan, but in that which had been most severely attacked by the insect. In this manner it was possible, without throwing the working plan out of gear, to cut a considerable proportion of the trees which had been eaten bare. In Ebersberg this was not possible, the devastation had been on too gigantic a scale. On 4,700 acres not a vestige of a leaf was left upon the trees, it appeared certain that none of these would recover, that the wood would rapidly deteriorate and morever that the bark beetle, (*Bostrichus typographus*) and other species* would, favoured by this vast number of dead and dying trees, multiply to such an extent, as to endanger the existence of other forests in the vicinity. It would not have been right to incur such a risk, hence it was resolved, without delay, to cut all the trees that had been eaten bare. As already mentioned, there was here and there a proportion of scotch pine. These, having been attacked much less, were allowed to remain and so were, of course, the beech trees, which formed a very small but uniform proportion in the spruce wood. The beech, having been overtopped by the faster growing spruce, were tall, lank, ill shapen trees with thin broom-like crowns, but will, nevertheless, in the regeneration of this vast area, be very useful. Of spruce timber the 4,700 acres yielded about 30 millions of cubic feet while the trees

* As a matter of fact it was, according to Dr. Pauly, not *Bostrichus* but *Pissodes Hercyniæ*, which was found most plentiful on the trees cut.

that had to be cut on the 7,400 acres attacked but not devastated, yielded another 23 millions. The total quantity cut amounted to 53 million cubic feet or more than one million tons of Spruce timber. Bark and twigs were burnt so as to destroy the eggs deposited upon them.

The State Forests of the Kingdom of Bavaria yield on an area of 2,300,000 acres, 102 million cubic feet of timber annually. The quantity therefore that had to be cut in the Ebersberg Forest in consequence of this calamity, amounted to more than half the total regular annual yield of the Bavarian State Forests. Extraordinary efforts, on a very large scale were made, in order to bring this timber to market in an economical manner. The great Railway Line which goes from Munich to Rosenheim and Innspruck, passes close by the forest, and a branch line 7 miles long, was constructed into the heart of the devastated area. The ground being level, the forest is divided into rectangular compartments by rides running at right angles to each other. A complete system of forest tramways was laid upon these rides and portable branch lines were thrown into the compartments. Each compartment measures about 42 acres.

Timber cutters were brought from all part of the country and lodged in barracks built in different parts of the forest. By means of these measures, which were carried out with great skill and energy, it has been possible to realize very good prices at these unexpected and gigantic timber sales. It will be readily understood, that the news of these arrangements created great excitement among timber traders. A great fall in timber prices all over Southern Germany was expected, and this created something like a panic among forest proprietors. In this direction also, timely measures were taken. The quantity of timber to be cut in the State forests of the adjoining districts, extending over a large portion of the kingdom, was reduced considerably. The good effects of this methodical and energetic system of action was aided by a circumstance of great importance. The spruce timber produced in the Ebersberg Woods has a very good name, it is slowly and evenly grown and is much prized. Of the large timber, much was taken across the Alps to Italy, while of the smaller pieces, a large proportion was bought by a large Paper Factory of chemical wood pulp near Mannheim. The tops and branches and the pieces of unsound wood which are only fit for fuel, have mostly been collected at the Government Wood Depôt which supplies the town of Munich with fuel.

In summer 1888 it is reported, in a most interesting paper on the ravages of *Liparis Monacha* by Dr. A. Pauly, Lecturer on Zoology at the University of Munich,* that a considerable number of moths of the "Nun" had been noticed, and it is estimated

*Allgemeine. Forst-und Jagdzeitung 1891. January p. 17, February p. 57. April p. 127.

that in the compartments which were severely attacked in 1889, there were in that year, 1888, from 6-10 moths per tree. Assuming four female moths on one tree and that they all laid the usual number of eggs which were duly hatched in the spring of 1889, it may safely be estimated, that in June of that year there were 400 caterpillars at work on each tree. As a matter of fact, an area of 1,600 acres was attacked in 1889 and on this area were seen numerous white spots on the stems of the spruce, and large heaps of the dung from the caterpillars were lying on the ground. Large sums were spent that year on the destruction of caterpillars, moths and eggs, but the effort was quite inadequate, the weather in 1889 and 1890, being much too favorable for the development of the "Nun" and apparently too unfavorable for its enemies. As the inevitable result of these circumstances, the eggs laid in 1889 by the female moths, the number of which may be estimated at 200 per tree, were hatched, and the consequence was, that in the Summer of 1890, each tree on the area attacked in the previous year, was inhabited by $100 \times 200 = 20,000$ caterpillars, which, being in good condition, thanks to the favorable weather, set to work to devastate the forest. It cannot be said, that the "Nun," has a strong tendency to wander. Swarms of the moth are occasionally driven long distances by the wind. Thus, last summer, while the insect was doing its work of devastation in the Ebersberg forest, it also appeared in some other forest districts near Munich in considerable numbers, but not sufficient to do any large damage. And when the moths in these forests emerged from the pupa stage, huge swarms of them were, on several occasions, driven by the wind into the town of Munich, where they appeared like clouds of large snowflakes, covering everything, to the amusement of the children, and to the dismay of the good citizens of that town, who sat in the public gardens in the evening to rest from the labours of the day over their cans of Bavarian beer. The moths were everywhere, on the table and in the beer cans. Oberforstrath Heiss, the head of the forest department in the province of Oberbayern, in a remarkable communication published in the April number of the "Allgemeine Forst und Jagdzeitung for 1891, states that as early as 1888, at the time of the Industrial Art Exhibition at Munich, millions of moths of the Nun made their appearance, being attracted by the brilliant light of the Marine reflector at the Exhibition. At that time a stiff gale blew in the Ebersberg forest, and Oberforstrath Heiss thinks it not impossible, that the moths were imported into the Ebersberg forest by the storm. There are also several cases on record on the shores of the Baltic, of swarms of the "Nun" having come across the sea with the wind.

These, however, as far as we know, are exceptional cases. The caterpillar only travels in search of food and that only for short distances. When nothing to eat is left on a tree, he lets himself

down or he creeps down and ascends the next tree. At last, when all trees and the advance growth under the trees in that locality are bare, hunger drives him to eat the leaves of the blackberry on the ground. And, as already mentioned, when disturbed by rain or wind or otherwise, the caterpillar lets himself down to the ground and is often blown considerable distances. In this manner the area attacked, which in 1889 only measured 1,600 acres, extended to over 12,000 acres in 1890. During this process of slow gradual migration in search of food, thousands of caterpillars perish from starvation, and last summer, huge heaps of dead caterpillars were lying on the ground. The stench of these putrifying worms, mixed with their dung, was almost unbearable. The number of dead caterpillars per tree was estimated at from 20,000 to 50,000.

The huge hole which has been cut into the Ebersberg forest, in the manner here described, has effected this great result, that the eggs over the entire area cleared, will be destroyed, and that any caterpillars which may come out in 1891 will find nothing to eat in their immediate vicinity. But, in the woods surrounding the area cleared, millions of eggs were deposited on the trees, and, should this year again prove as favorable for the "Nun" as its predecessor, the destruction may, nevertheless, extend over that part of the Ebersberg forest which had not previously been touched. Nevertheless, the most effective step in order to arrest the progress of this mischief, has been taken and it will be readily understood that there were many who wondered why the Wurttemberg Forest Administration had not acted in a similar manner. Those, however, who were familiar with the circumstances in these two forest districts agreed with the Wurttemberg authorities, that their action was justified by the circumstances of the case. Great, therefore, was the rejoicing when in March the newspapers announced, that the trees which had been left standing in the Weingarten forest range showed signs of drying up, and that preparations had been made for cuttings on a very large scale. The fact is, that towards the end of February, the tops of the trees commenced to die, the last or inner layers of the back showing brown spots. The same thing was noticed in the bark at the base of the stem. The cold was unusually severe, with deep snow on the ground in January and the first part of February, and this exceptionally severe weather may have had an injurious effect. Whatever the cause of this unexpected mischief may have been, there was no help for it, but to cut the trees which were dying, and it is estimated, that including 700,000 cubic feet cut in 1890, altogether 3,500,000 cubic feet will be cut in the compartments of the Weingarten range, which had been devastated by the Nun. Even with this, the fellings in Weingarten are small compared with the 53 millions of cubic feet cut last year in the Ebersberg forest.

The third forest district, in which destruction on a large scale was worked by the Nun in 1890 is the "Dürrenbucher Forst" situated 50 miles north of the Ebersberg forest, from 3 to 4 miles south of the Danube on undulating ground, at an elevation above sea level of 1,300 feet The total forest has an area of 12,000 acres, of which 1,800 were attacked by the insect. It is stocked partly with pure spruce, partly with mixed wood, spruce, Scotch pine and beech. The same peculiarities were noticed here as at Weingarten. The spruce suffered most, while mixed woods were much less affected. The destruction was most severe in low sheltered places, while trees standing on hillocks and ridges had suffered much less. This forest is particularly interesting, because measures were taken with considerable success to hem in the ravages of the insect and to prevent its spread. In July 1889, moths were seen, they were estimated at from 4 to 5 per tree. Damage by the caterpillar was not noticed and it was hoped that bad weather, which occurred at the time when the eggs were to have been laid, would have prevented this operation. On 9th June 1890, however, it was found that the caterpillars were at work, and forthwith a plan of action was framed and carried out by special officers and establishments posted to the forest district. In two essential points this forest was different from the two districts first described. Natural reproduction has always been, and is the rule here, and it was more of a mixed wood, than the others. Hence greater irregularity in the age of the trees and more underwood and advance growth. After the outer limits of the area attacked had been ascertained, it was determined to prevent the spread of the caterpillars and the extension of that area, and this was effected by the formation of protection belts around the area already attacked The advance growth, even under old woods of the Scotch pine, consisted chiefly of spruce, it was densely beset with caterpillars and greatly tended to facilitate their onward movements and thus spread into woods not yet attacked.

On the protection belts, which were made 100-130 feet wide, three operations were undertaken. *First*, on all old stems rings 12 inches broad of tar and glue were applied at a convenient height, about 4 feet from the ground. This mixture of tar and glue has for some years past been specially prepared and has, as previously mentioned, been employed on a large scale against the ravages of the scotch pine moth, the well known *Gastropacha Pini*. To make the glue stick on the stems, the rough outer bark is scraped off with a sharp knife, which gives a smooth surface to the inner reddish back. Hence this operation is commonly designated as "robben" to redden the stem. These rings or belts of glue, if the mixture is good, remain sticky during 2 or 3 months and they effectually prevent the caterpillar from ascending the tree. *Secondly*, all underwood was cut and burnt as far as it

could not be utilized. Poles fit for sale were barked and the bark was burnt with the rest. For this purpose special fireplaces were prepared and surrounded by a circular ditch with steep sides, to prevent the spread of the fire and the escape of the caterpillars which, as soon as the underwood was heaped up inside the ditch, rapidly collected in the ditch and were destroyed. The moths commenced to swarm in this district while huge masses of caterpillars were still at work feeding. Hence the fires lit to burn the underwood were also used to attract to destroy the moths. For this purpose the fires were lighted at night and kept up until midnight. Between 9 o'clock and midnight the largest swarms of the moths appeared, a portion were actually burnt, the others were stupefied by the heat, fell to the ground and were easily killed. Pine torches were also used with large screens behind them, smeared over with glue on which the moths were caught. *Thirdly.* Extraordinary efforts were made to destroy as many caterpillars and moths as possible Gangs of women with blunt brooms and long handles were busy in the protection belt and elsewhere in the forest, in killing the caterpillars, which were set on motion by the cutting of the underwood and other operations undertaken. For the destruction of the moths 300 labourers and 80 boys under their masters were employed. This work could, as a rule, only be done early in the morning from four to half past eight o'clock. Later in the day the moths fly about and cannot be caught. Only on cool rainy days do the moths remain quiet during the day and can be destroyed.

To return to the protection belts, the great object aimed at was, to stop the spread of the caterpillars by making it impossible for them to ascend large trees and by destroying the food which the underwood had furnished them. Here and there the success was not complete, and in such cases an additional protection belt was formed outside the one first established. Upon the whole, the result was most satisfactory, and the destruction was confined to less than a sixth part of the entire forest. In some cases ditches with steep sides were used in addition to the protection belts and the caterpillars collected in them in large masses. I draw attention to what has already been stated, *viz.*, that in Ebersberg, spruce poles, the bark pulled off and smeared with a mixture of tar and glue, were used with some success to prevent the spread of the caterpillars into compartments not yet attacked by them. The success attained by means of the these and other measures, which it would lead too far here to detail, in the Dürrenbucher forest was the well earned reward of measures promptly devised on the spur of the moment and carried out skilfully and expeditiously.

It has been maintained, and probably with justice, that the Nun has its original home in the scotch pine wood. Here a few samples of the moth may be found every year, whereas in

spruce forests in ordinary years the Nun is rare or absent. And in the extensive scotch pine forests of Franconia, as well as in some scotch pine forests near Munich, the insect had multiplied to an unusual extent during the 3 years from 1888 to 1890. At other times also and at other places the insect has done damage in scotch pine wood. There has, however, never been devastation in pine wood on a scale as gigantic as in spruce forests. Why this should be so, is not at first sight easy to explain. There may be something in this, that the needles of the pine are only eaten partially, whereas the caterpillar eats those of the spruce from the top downwards to the very base. Again, the bark of old spruce trees is rough to the top, whereas on old trees of the scotch pine the upper part is smooth. Dr. Pauly thinks that even in the lower rough portions of the scotch pine, the bark is not as favourable as the spruce bark. It has already been mentioned that the "Nun" is polyphagous and generally it *shows a great partiality for the leaves of the beech. Caterpillars* of this insect fed on beech leaves are reported to attain an unusually large size and to produce particularly fine and well developed moths. Nevertheless, no case is known of the "Nun" having multiplied in beech forests to such an extent as to create serious apprehension. One reason of this may be that, on the smooth bark of the beech tree, the eggs do not stick. Another is, that the beech, like other deciduous trees, produces a fresh crop of leaves as soon as its leaves have been eaten by insects. The oak does the same, and it is not an uncommon thing to see all trees in an oak wood eaten bare in spring by that small grass-green caterpillar, *Tortrix viridana*, and after the lapse of a few weeks, to find the trees clothed with fresh foliage. The bark also, though that of a coniferous tree, being deciduous, recovers rapidly, after the first crop of leaves has been destroyed by *Tinea lancinella*. The spruce too makes an effort, so to say, at recovery, but that effort is weak and ineffectual. In October last, in the Weingarten forest, on many trees which had been eaten bare or nearly so by the caterpillar, the buds intended for the spring of 1891, had opened and brought forth small tufts of tender leaves, these were killed by the cold of winter, and others which here and there came out in spring, had not strength to restore life to the exhausted tissue of the branch and it consequently withered. There is, however, a difference. Young plants of the spruce show a greater reproductive power than old trees. Other conifers, such as the silver fir, and perhaps even the scotch pine, though not to be compared to deciduous trees, yet seem to have greater powers of reproduction than the spruce. Hence it is hardly to be wondered at, that all the great devastations of the Nun have been in spruce forests. Numerous such are on record in Saxony (Voigtland) in 1790, in Thuringia in 1829-30 and 1835-40, in Poland, Silesia and Eastern Prussia from 1852 to 1858. In all

these cases there has been loss in material on a gigantic scale. The timber of the extensive forests which was killed wholesale, deteriorated and was attacked by the bark beetle. The devastation in the *Ebersberg Park* has been the first instance in which it has been possible to utilize the whole of the timber killed by the insect, and the *Dürrenbucher Forst* has been the first case of a really successful battle against the calamity.

In India there has not, as yet, been any extensive damage to forests by insects. Pure or nearly pure forests, in which one species prevails, fortunately are the exception and not the rule. In Sal forests only has there been a commencement of such damage; nevertheless it may not be without practical value to draw attention to some of the leading facts connected with insect damage in Europe. The beginning of the calamity with which the present paper is concerned, can be traced back to 1888 and by 1890 the insect had multiplied in many scotch pine and spruce forests of South Germany and Austria, for its ravages extended over Bohemia and lower Austria. But everywhere the damage was confined to certain areas of limited extent, it was severe only in spruce forests, and devastation on a really large scale was limited, in South Germany, at least, to the three forest districts: Weingarten, Ebersberger Park and Dürrenbucher forest. In these localities the multiplication of the insect was due to local causes. The fact that the damage was confined to the interior of the forest while the edge escaped, seems to show conclusively, that the insect was not imported from a distance. The experience of the coming summer will show, whether this view holds good generally, or whether the mischief has not spread by the flight of the moth to forests which had hitherto been free from it.

The conclusion seems justified, that in those regions north of the Alps from the Lake of Constance to Vienna, where the calamity of 1880-90 took place, the climatic conditions of those three years favored the multiplication of the Nun in a remarkable manner, and that, in certain localities, such as the three forest districts here described, the effect of these conditions had been much intensified.

On previous occasions it has often been observed, that after the devastation of the Nun has lasted for three years, its vitality seems to diminish. This may be explained partly, but not entirely, by the increase of its enemies. A disease often breaks out among the caterpillars, as if they were uneasy and uncomfortable, they begin to wander up and down on stems, posts and the like; on the spruce they congregate in large masses at the tops of branches, and then they die without making any attempt at feeding. The next few months will show whether the point of exhaustion and multiplication of its enemies has now been attained, or whether the calamity is still extending further.

The "Nun" is not likely to trouble Indian Foresters, and this lengthy account of its ravages may to some appear superfluous. What has here been said may, however, be useful in so far as it teaches the old, but all important lesson, that mixed forests have many advantages over pure forests. Should any insect calamity ever give real trouble to Indian foresters, systematic and methodical study, of the life history of the insect, will be the first point to aim at. In regard to the placing of its eggs, the larva and pupa state and the perfect insect, each species has its own peculiarities which must be studied, before an attempt can be made to adopt remedial measures that shall be *really useful.*

GRAZING STATISTICS AND GRAZING UNITS.

Will you allow an obscure divisional officer to make a few suggestions concerning the grazing figures given in some of our Forest Administration Reports for last year, form No. 55 ? I might refer to almost all the reports without exception, but it will be sufficient to extract figures from two or three and this I do below :—

PUNJAB REPORT. RAWALPINDI DIVISION.

Grazing by permits (No. of cattle) 2,592. Value Rs. 111.

KANGRA DIVISION.

Grazing by permits (cattle) 3,039. Value Rs. 1,271.

CENTRAL PROVINCES REPORT. BALAGHAT DIVISION.

Grazing animals, No. 137,712. Value Rs. 24,216.

BHANDARA DIVISION.

Grazing animals, No. 89,448. Value Rs. 16,384.

BETUL DIVISION.

Grazing buffaloes, No. 8,022. Value Rs. 5,299.

N. W. PROVINCES AND OUDH REPORTS. DEHRA DUN DIVISION.

Grazing animals, No. 29,608. Value Rs. 6,099.

Any number of examples might be taken, and I hope the Conservators of the above circles will kindly forgive me for quoting their figures.

What is meant by the " number of cattle (2,592)" or by " animals, No. 137,712 " ? What animal is referred to ? What is the unit ? Is it one head of cattle grazed for a year, or one head for one month, or for three months, or is the number here given merely the aggregate number of animals for which permits for all periods issued ?

Until a few years ago, in the Lower Bengal Report the " number of cattle " given in this return was in reality the number of cattle for which permits issued, and, on its being observed that these permits were some for one month, and some for other periods

and that the numbers of cattle had all been added together indiscriminately into one total, a new plan was adopted, and the entries now in the body of the return distinguish the periods, and the "abstract" at the end of the return gives the number of grazing units, a unit being defined as *one animal grazed for one month.* To avoid increasing the length of the return, it would probably suffice to enter merely the number of grazing units, a foot note defining the unit, and to omit all details of length of periods, and I would invite attention to the note at foot of the Bengal return, No. 55, which is as follows:—

"NOTE.—For the purpose of this abstract of grazing, permits for grazing issued for various periods have been reduced to, and are expressed in their equivalents in one-month permits. The unit is therefore one animal grazed for one month, and the number here given, if divided by 12, will give the average number of animals grazing daily throughout the year."

Of course I have no right to assume that the figures of the above reports do not refer to animals grazing all for the same period, but in that case, I would suggest that for record and for the information of the public, the length of the period should be mentioned. What we ought to avoid is such figures as say:—

1,000 cows grazing on one-month permits.
500 " " " three-months permits.
200 " " " twelve-months permits.

All being added together into a general total of 1,700 cows, which total would not properly represent the case. The 500 and the 200 cows should, of course, be reduced to the same denomination as 1,000 cows, and we should have, in this case, a total of $1{,}000+1{,}500+2{,}400=4{,}900$ cows, if one unit is one animal grazing for one month.

A plan such as the Bengal plan, which I should like to recommend to the consideration of Conservators, enables the reader to form an idea of the amount of grazing, and whether light or heavy, if he knows the area grazed, and this last is now given in the Annual Reports. At any rate, it allows of a comparison between the figures of successive years, which is impossible unless the unit is the same throughout.

To resume, would you allow me to suggest for consideration that these returns should shew, not vaguely as now, "number of animals," but the number of grazing units, and that a note at foot define the term "grazing unit" as is done in the Bengal Report, and further that a distinction be made between the different animals? One figure should refer to cows, and then to buffaloes, another to goats, &c., &c. I see that this distinction between the kinds of animals is observed in the returns for the Northern Circle, C. P., but not in the Southern.

3rd April, 1891. E. G. C.

RAB.

The remarks on *rab*, at pp. 11 and 12 of your January-March number, treat the question as one principally of *ash-manure.* This is, I think, a mistake, though the conclusion come to, that tree-rab is indefensible, is perfectly sound. Here in Bombay, the most respectable opinion is, that the magic lies in the *fire*, the *ash* being a very secondary matter. The great point is, to obtain a fire hot enough and enduring enough to penetrate the soil to the requisite depth, neither smouldering vainly on the surface, nor flashing over in evanescent flames. This is supposed to exterminate all intruders, plant or insect, living or hybernating in the soil. It also has doubtless an effect on the physical condition of the soil, and on its chemical composition, by producing nitrification or otherwise. The *ash* cannot be the principal object, since one man will burn his bed in March, or even February, while another will defer it till the end of May, if it suits his convenience in other matters. The latter will, of course, profit by much of the ash. But the former will not, for the high winds prevailing will have scattered it to the four quarters of heaven, leaving only a patch of blackened soil. But the crops will be equally *good*, other things being equal, or at any rate public opinion has found no reason to confine the period of burning within narrower limits than those of the dry season. As to the alleged necessity of *tree-rab*, it is doubtful. The Revenue Officers strike for it because the people demand it (where forest is available). The concession keeps things comfortable for them, and the *profit a prendre dans le bien d'autrui* is much too valuable to be given up without a struggle. The agriculturist chiefs strike for it partly for the same reason, and partly because one of them, on making the discovery that rab in general was not pure idiocy, but had actually a sound basis for him to put into scientific language, became so pleased with himself that he lost his head with delight and pushed his theories regardless of the expense. What could a poor forester do against such foes? Fortunately, nature is on our side, and is daily undermining their stronghold. In some parts, people are offended if you suggest the use of grass or leaves. Go twenty miles east, and you will find a plot of branches and a plot of pure grass side by side. Go ten miles south, you will find a thin layer of cowdung suffices. Go twenty miles north (or twenty minutes ride for that matter) and you will find pure teak leaves in use, gathered off the ground in big baskets. The leaves and the grass usually are sprinkled with a little dust to moderate the rate of burning. I have never seen the complicated superposed layers approved by the agriculturists. The vast majority of rab beds consist of one, or two, or rarely of three layers. Now, in the heart of this wonderful rab-demanding rainfall, it appears that there are villages which actually do with *fish-manure.* But nature is with us, and I have not a shadow of doubt that before

many years are out, tree-rab from State Forests will be as dead as Queen Anne.

F. GLEADOW.

II. SPORT.

MY ·360 TIGER.

It was the Merry Month of May—or very near it—and none the better for that fact. "Hoar December." Oh! for a little "hoar"—would have done as well, in the matter of merry geniality. But there it was, and if not liked—as it certainly was not—it had to be lumped—as it certainly was—over lumps of basalt, for about 1,500 feet up. I am not fat, unless about the cervical region. I could not get fat if I tried, leastways not without stealing it, or acquiring it in some less nefarious but equally external manner, but I know exactly what Shakespeare meant, when he talked about "larding the lean earth." You cannot do it,—not *really*—if there is a breath of air stirring. But when every leaf is off the trees—as in the merry spring-time, and the geniality of the atmosphere is as that of the abode of old Get-thee-behind-me, then only can a really lean and skinny, shrivelled and weazened mannikin, like myself, properly "lard the lean earth," to the satisfaction (! ? !) of both parties.

This district has been thoroughly shikarred by a previous Collector who presented each of his beaters with one or several guns, and the necessary licenses, if one may go by circumstantial evidence. There are also, gun for gun, about as many unlicensed. The consequence of which is, it may be said, without any excruciating mathematical proof, or logical inference, but in plain, common, everyday English, that the country is cleaned out, that the lordly sambhar now lords it in the happy hunting grounds, that the nylgai is written, as the Romans wrote it, with a *nil*, that the tiger has had to follow his food, and that, in short, the Forest Officer is the only Shikar left.

The above facts may account for my carrying only a ·360 express, on the off chance of a hare, or by great good luck, of a bukri or microscopic deer, (surviving because no native gun can hit it) instead of a rifle more worthy of my fame, or, to be more modest, more fitted for a man of double my strength. The above facts again, coupled also with the fact that I had already expended most of that strength, may also account for the fact that not having seen a tiger for more years than I can remember when sober, I should on this occasion, while carrying the little ·360 on another man's shoulder, almost walk on top of one, which was, as may happen to the bravest, also when sober, the first to bolt. The ground being tempestuous, and the forest thickish, I was searching the intricacies of the jungle, and of the Dictionary of Expletives, and of my favorite author Athanasius, and

of the roots of my hair, (which would not come out by fistfuls because the perspiration precluded any chance of a good grip) when that tiger must needs stop in a visible situation across the valley, to see who had dared to intrude upon its lair. The range was somewhere between 200 and 250 yards, nearer the latter and the rifle was well, a curiosity. Originally a double, simple ·360 rook rifle, I had it bored out for the express case with the result that it was point blank, and wonderfully accurate, at 300 yards; but threw high by some yards (to limit myself to the Revenue standard of exaggeration) at shorter ranges. There was also an interesting uncertainty about reloading in a hurry, owing to the extractor catching the top of the breech-block. The sights are beautifully fine, and as there was no time to prospect around for a rest, I just took a careful standing shot, and—bowled over the tiger, like a ninepin. But being fully aware that the nine-lives-of-a-cat story is something more than the statement it reads like, thought it advisable to "wet t'other eye," or barrel, and did so. The result, as afterwards shown, being a clean miss. (Good advt. for Pear's Soap somewhere here, but no time to elaborate it.) The other result, as might have been foretold, was to wake up the tiger, and everybody, meaning we five bodies, vowed "a hit, a palpable hit." The tiger, displaying an intimate knowledge of the Commentary of Athanasius on the Dictionary of Expletives, went tobogganing in a loud voice down the hill, tail end first, and it became something more than evident that there would be a considerable advantage in keeping above, rather than below, the subject of discussion, which was, I repeat courteously but firmly, a tiger in tantrums, and not an offence compoundable under § 243 (*a*). We five, including a patel with my walking spear, and a beat guard anxious to show his zeal and incorruptability, by flourishing his marking axe, and stamping the broad arrow on imaginary tigers' skulls, went after that tiger, and very soon found that it had no monopoly of the toboggan business, though the roars from our party were painfully inferior. After consultation, we found that by going round the same way as the tiger, we could just, if not over-balanced by inconsiderate roars, keep our feet, and then we trusted to keep our bodies. We had not descended a quarter of a mile when the roars became distinctly disturbing to our equilibrium, and trees came rapidly to a premium, either as a temporary break, or as a possible, not to say probable, refuge. The uncomfortable part was, that we could not see the unsociable beast, though knowing that it indulged no fads and crotchets as to our own precise locality. Its roars and growls seemed to come from just under our feet, and we were afraid, every man jack of us, that the missing sociability might become evident, all in a lump, in an unexpected and unofficial, not to say aggressive, manner. Still, we did not dare bolt outright. At length Keeneye spotted the beauty, (it was really *striped*, and spotted at the same time

and place) and showed it me, and I did not like it at all, at all, and the first thing I did was to motion them all up trees, which they had, no doubt unconsciously, already selected, and they were not long in showing off their climbing powers, as every broken twig or crushed leaf had elicited either a growl or a roar. Now I am extremely fond of music and do a little in the Church emptying line myself, and the others simply gloried in the style of music employed to drive away the Devil at native weddings, and they would have given large sums, had a deaf and wealthy Bunnia come along to get within ear-shot of one. But this music jarred upon our nerves, and upset our stomachs, and generally struck us as being vastly inferior to the harmonies of "Home sweet Home," or "Chota lal chirya baitha upar lat." However, there we were, and there was the tiger, and its eye was upon us, and I had but three small cartridges, one of which was morally certain not to find its way home if in any way rudely flustered. The tiger was under a clump of bamboos, and mostly concealed. The only things clearly visible were the lashing of its tail (an unsatisfactory mark) which seemed to grow out of its head, and its vile temper. I thought to myself, if it were not too late, I should pray that Heaven preserve me from having a tiger's temper. But as I have got one, I just fished about for the clearest view to be got, and squatted down there to consider, well knowing that if I once covered the beast, that pesky little rifle would go off, like the Chassepot, of itself, and perhaps get me into as much trouble. I thought to myself, as I sat figuring out the trajectory, and calculating how to dodge this and the other bamboo, now my friend, are you the common coward, that sees his enemy and hesitates, or are you the rash headstrong idiot that goes for an enemy stronger than himself when the ground favors that enemy? Then I thought that a decision of the question either way would not make two pins difference in my action, and might be deferred until philosophical reflection was no longer disturbed by a tiger-skin, *my* tiger-skin, with a tiger in it, roaring stale platitudes about possession being nine points of the law, and teaching your grandmother to catch tartars, &c., &c. Then I thought that "payment by results" is the unjust but expedient and inflexible order of the day. I have established relations with that roaring tiger-skin there, which nothing but death can sever, and what is more, I am not going to sit here all day, having a lot more work to do and that brazen sun up there more to be dreaded than forty tigers. Then the tiger got up, and said in an abominably uncivil tone, that I had better look sharp anyhow, or he would have to come out and see about it, and lay down again, bad to see as ever. So I made a final calculation, how many feet below to aim, and with elbows on knees took a steady pot shot. The marking-axe was nowhere visible, but I spotted the spear, out of reach, leaning against the

trunk of a tremulous sapling, on which the bearer was clinging, as a chameleon might do, and displaying most of his numerous colors, from anxiety on my behalf. The bullet seemed to get home, as the result was a sit-up-and-roar till the barrels vibrated so that it was vain to look for the foresight. So I took out the empty case, and substituted the remaining cartridge, thankful to be allowed to insert it in comparative peace. Then I took another steady pot, on which the tiger got up roaring, and turned round, and lay down reversed. And then the last shot, wondering whether I should be found a week hence, a skeleton tied with its pocket hankerchief up in a supposed life-saving sapling, over the still terrible carcass of a tiger, or whether,—oh ! confound it all, let's see ! and the final bullet speeds, with the only result of another ferocious growl, but thank goodness, no charge. Rather unsatisfactory ! Then I got up, wondering if it was safe to call the men down from their trees, and eventually did so, and we made our way, unarmed and gingerly, up to the place we had left. I sent one man 10 miles to fetch the big rifle, and cartridges for both, and with the others went a killing journey up and down the hillsides to earn my day's pay, getting to my leafy shelter, (I had no camp, being unable to bring it) about 2 p. m., I drank a bottle of soda and two quarts of beer straight off, and was still parched and panting with exhaustion and incipient sunstroke, ate a little for conscience sake, and went to sleep leaving instructions to call me when the other rifle arrived. Then started off, more numerous this time. The trees were not enough for the men when the tiger was spotted by an advance climber, about 30 feet from me, and I could not see it from the ground. I had been carrying the little rifle, still loth to rob it of an unaided victory, but thought, the tiger having moved some distance since we left it, with much regret, that it was now high time to handle the big one, and accordingly took it. Luckily the beast was dead, and all that remained was to sling it on a bamboo and get it home, which was done in triumph, as it was responsible for six cattle from my temporary camp alone. We skinned it after dinner, by the weird light of the torches, and the men went home, delighted with their rewards and the riddance. There were only two bullets in the beast, the first, and one almost between the eyes, but passing below the brain. Those (where's the Dictionary) bamboos got the others. So my latest tiger is spoilt by the shame of bad shooting. I have written to the Mamlatdar for the reward, as a private individual, but fully expect he will refuse it on the ground that a Forest Officer may not shoot a tiger without the previous written orders of the Collector.

VELLEDA.

Camp Satara, East Khandesh.

WOOD PULP INDUSTRY.

Various forestry interests have been canvassed by the agents who are assigned to this Division, as yet with incomplete results. The one to which I wish to direct special attention, as referring to the most important development in the use of forest products, relates to the manufacture of wood pulp.

It can be said, without fear of contradiction, that in no field of industrial activity has a more rapid development taken place within the last few years than in that of the use of wood for pulp manufacture. The importance of this comparatively new industry for the present, and still more for the future, can hardly be over-estimated. Its expansion during the next few decades may bring revolutionary changes in our wood consumption, due to the new material, cellulose, fiber or wood pulp.

Though rapid in its growth, the industry has by no means reached its full development. Not only is there room for improvements in the processes at present employed, but there are all the time new applications found for the material. While it was in the first place designed to be used in the manufacture of paper only, by various methods of indurating it, its adaptation has become widespread; pails, water pipes, barrels, kitchen utensils, washtubs, bath tubs, washboards, doors, caskets, carriage bodies, floor coverings, furniture and building ornaments, and various other materials are made of it, and while the use of timber has been superseded in shipbuilding, the latest torpedo ram of the Austrian navy received a protective armor of cellulose, and our own new vessels are to be similarly provided. While this armor is to render the effect of shots less disastrous by stopping up leaks, on the other hand bullets for rifle use are made from paper pulp. Of food products, sugar (glucose) and alcohol can be derived from it, and materials resembling leather, cloth, and silk have been successfully manufactured from it. An entire hotel has been lately built in Hamburg, Germany, of material of which pulp forms the basis, and it also forms the basis of a superior lime mortar, fire and water proof, for covering and finishing walls.

According to the manner in which the raw material for the industry shall be secured, it may prove either a new enemy to the forest or it may prove a saving element, rendering rational and profitable forest management in the United States possible and leading

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Extract from the Report of the Chief of the Division of Forestry, U. S. A. for 1890, by E. Fernow.

toward it. As I have shown elsewhere, such management in our natural woods depends largely upon the opportunity of marketing wood of small dimensions and inferior material, and this, by an economic development of the pulp manufacture, may be to some extent secured. Self-interest should lead the manufacturers to a study of the problem of forest management for continuous supplies, and mill men should combine with them to have the refuse, slabs, etc., worked up into useful material.

Ten years ago there were in Europe about five hundred wood-pulp establishments, making in round figures 15,000 tons of ground pulp, valued at over $5,000,000. With the development of the chemical processes since then, it is hardly possible to tell from day to day how fast the production increases. To arrive at an idea how far this industry has developed in this country, a canvass has been made among the pulp mills, the results of which have been tabulated below.*

In connection with this, considering the probable importance of the subject to forestry interest, it may be desirable to explain briefly the various processes, their advantages and disadvantages, their significance in connection with our forest resources, and to add suggestions which may be helpful in the development of the industry.

In the following brief statements I have followed, in part, the excellent résumé of the present state of the chemico-technical use of wood by the referee at the Vienna International Agricultural and Forestry Congress, where, if a more liberal policy had permitted a representation from this Department, probably much of additional value in this and other lines might have been learned. For the chemical reactions the recently published Dictionary of Applied Chemistry, by T. E. Thorpe (1890), has also been consulted.

It may first be stated that cellulose is the preponderating constituent of all vegetable tissues ; in fact, elaboration of cellulose is synonymous with growth. In addition to the cellulose there are present in the wood nitrogenous substances, resins, gums, and (mineral) ash, which are to be removed, more or less, in order to produce the fiber or pulp. To do this economically and in such a manner that the fibre may remain long, pure, and white and the mass preserve its "felting qualities as much as possible, is the aim of the various processes.

About half of the wood substance consists of cellulose, the soft woods containing however, more than the hard woods; one reason

* The first suggestion to use fibre for paper manufacture was made by a German, Jac. Chirist. Schaeffer, in 1772; the first patent of commerical importance for chemical production was obtained by Watts & Burgess in 1853, and a small mill erected in London about 1855; the first large pulp mill was established in Manayunk, near Philadelphia, in 1865; in 1868 in England, in 1871 in Sweden, and soon afterwards in Germany, where the modern processes have been mostly developed.

why the former are preferred in the commerical production of pulp.†

There may be now distinguished three classes of wood pulp, according to the manner of its manufacture, namely, mechanical, pseudo-chemical, and truly chemical pulp.

The preliminary preparation of the wood is the same for the different processes. It includes the cutting and splitting to suitable size for handling, the removing of the bark on the "barker" (a planing mill with two blades, or other contrivance); the removing of knots by the "knotter," an augur, and the removing of the pith by the pith cleaner, when necessary. For the chemical processes a further preparatory operation consists in the "chipping," which is done by knives placed on the face of cylinders, 5 feet in diameter, making 150 revolutions, having a bite of one eighth inch; the "chips" are further reduced mechanically by crushing rolls, after any knots and discolored pieces have been picked cut from the moving apron which carries the chips from the chipper to the rolls.

(1) The *mechanical or ground pulp* is produced by grinding the wood, after proper preparation, on rapidly rotating stones under constant flow of water (Voelter process). For this process round wood is used of 4 to 8 inches diameter, cut into lengths of 10 to 20 inches, according to the face of the grindstones against which the wood is pressed lengthwise with the fiber.

Emery wheel cutters, using 40-horse power, will produce 50 pounds per hour of dry pulp, while natural stones, producing 25 per cent more pulp, require more than double the power. The ground mass, looking like thin gruel, is pumped into tanks, screened into vats, and then run off in thick sheets on the "wet machines" on which it is dried, folded, and pressed, containing still at this stage 60 per cent of water.

(2) *Brown wood pulp* is mainly a mechanical pulp, except that the wood is steamed before grinding, under a pressure of 2 to 6 atmospheres. This steaming, with a heat at 300° Fahr., produces a chemical reaction, the soluble non-volatile ingredients of the wood forming powerfully acid bodies, which aid in the separation of the fiber; their corrosive action makes it necessary to use for the digesters vessels lined with copper or lead. After the wood is steamed, it is ground between millstones or in a rag engine (system Rasch & Kirchner). To avoid the acid reaction, and the necessity of noncorroding vessel linings, the addition of neutral sulphites has been proposed, when the organic acids combining with the base, are neutralized, a sulphite residue remaining. A sodium sulphite solution (5 per cent Na_2SO_3 with a high temperature, 356° Fahr., is used, the action of which, besides neutralizing the acids seems mainly to consist in keeping the path open for continued action of the heat and water. It is claimed that this latter process has disadvantages in point of economy.

(3) *Chemical wood pulp*, or cellulose proper (in this country called chemical fiber), is produced by treating finely divided wood or wood shavings with various chemicals, which dissolve or render soluble the incrusting substances, leaving the fiber as long, elastic, and pure as the raw material will furnish it, while the above mechanical processes naturally shorten and deteriorate the fiber mechanically.

The chemical processes can be again classified into alkaline and acid processes, according to the kind of chemicals used. Of the many methods proposed only four or five have been developed with industrial succeses.

All these processes have in common the mechanical preparation of the wood, as described before, preceding the boiling with chemicals under pressure (which requires hermetically closed digesters, with anticorrosive linings) and subsequent washing out of the residual solution, screening, draining, and drying on "wet machines," and most of them, to produce the desirable white color, require a special bleaching process. The partial manufacture of the solvents and the recovery of the spent liquor of solution, or else its treatment for other useful materials, forms also part of the processes. Since the chemicals are apt to attack

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† The following percentages of cellulose in air-dried wood were determined by chemical analyses :—

Poplar	62.8	Basswood	53
Fire	57	Chestnut	52.6
Willow	56.7	Locust	48.4
Birch	55.5	Beech	45.5
Pine	53.3	Oak	39.5 (45.9)

the fiber itself, a careful adjustment of their proportions is essential, otherwise the loss of yield may increase unduly. The drying, after the processes of purification is also an important part, since it is to be considered not a mere desiccation, but a chemical reaction, which, if not properly conducted, results in hardening and agglutination of the fiber.

Of alkaline processes there are two prominent :

(a) *Soda pulp* is produced when caustic soda lye under pressure and steam heat of 300° to 360° is used to remove the incrusting substances, carbonate of soda or solway salt and caustic lime being used to obtain the caustic soda, which can be easily and cheaply recovered by evaporation and calcination, the dissolved organic matter supplying the fuel for the latter part of the process of recovery. About 75 to 80 per cent is thus recovered as "black ash." The tank wastage, consisting of lime, silicates, and impurities is apt to become a nuisance, if allowed to flow off into rivers, etc. The strength of solution, proportion of it to the material, temperature and duration of the digestion, vary considerably with different woods. The chemical changes are very complex and as the chemical action extends to the cellulose itself, the yield is thereby reduced.

(b) *Sulphate pulp* results from digesting the wood at a temperature of 300° to 360° in an alkaline mixture in which sulphates preponderate. This process, which is successfully worked in Europe, but seems unknown in this country, contains several points of economic importance. The liquor is made by treating sodium sulphate (glauber salts, 90 pounds of sulphate to 100 pounds of dry pulp) with caustic lime, when a certain proportion of the former is transformed into caustic soda. The liquor, after the boiling, is evaporated, calcined, and treated with lime, by which it is recovered as sulphide and hydrate (caustic soda) in nearly equal proportions, together with some sulphate; and with the addition of some sulphate (about 20 per cent) to compensate for the unavoidable loss, the cycle of operation is kept up. The pulp from this process is of very high quality, similar if not superior to soda pulp, the only objection being that in consequence of the presence of some organic sulphur compounds it is somewhat malodorous, which, however, it might be possible to overcome. With cheap materials to begin with and easy recovery of the liquor, this should prove a very economic process. It is really almost the same as the one described as soda pulp, only that instead of buying the more expensive caustic soda, this is obtained in the process itself from cheaper and more easily transported materials. A recent patent by G. Hesse proposes boiling the wood with bisulphate of soda, then grinding the wood and using the spent liquor for the manufacture of sugar and alcohol.

The acid processes are more numerous and have come lately more to the front. Passing by the Bachet-Machard process, which, using dilute hydrocholoric acid, was employed in Switzerland for making coarse packing paper, and the Tilghman-Pictet process, employing sulphurous acid in lead-lined vessels, we come to the so called (c) *sulphite pulp*, which is obtained when removing the incrusting substances by boiling the wood with acid sulphurous salts like the acid sulphite of lime ($Ca(HSO_3)_2$), or bisulphite of lime and magnesia $\binom{ca}{mg}(HSO_3)_4$).

The various processes of this class (developed by Tilghman, Mitscherlich, Ekman, Francke, Graham, Macdougall, Flodquist, Kellner, and others) are identical in principle and differ only in technical detail. The boiling liquors vary in regard to acid strength (3 to 5 per cent) and proportion of base, temperature, and duration of digestion 300° to 350° and thirty to eight hours). Various woods require, of course, variation in strength of liquor, etc. All require special apparatus protected against the corroisive action of acids by a lead or other (special brick) lining. There are also digesters in use made of a bronze metal which resists the corrosion.

While these are laboratory results of European chemists, the following percentages, given by Charles M. Cresson, relate probably to pulping results :—

Hemlock	45	Spruce	32
Walnut (very dry)	42	Cherry	32
Birch	40	Chestnut	30
Poplar (seasoned	37	Hickory	22.6
Poplar (unseasoned)	30	*Maple (unseasoned)*	21.2
Yellow pine	36.5	Ash and oak (unseasoned)	20.6
White pine	33.25		

The general practice brings out still smaller results.

Under a recent patent (F. Salomon) a serviceable lining is obtained by heating the vessel filled with sulphite liquor or gypsum solution, which, when boiling, will deposit a durable crust. This crust, which forms itself during the process anyhow, used to be considered a nuisance, as it resisted removal, until it was discovered that its presence answered as a protective lining. It is claimed to be safer than the combined brick and lead lining for the reason that the latter is hidden from possible inspection and any leaks occurring unforeseen give rise to explosions. The same patentee proposes several other methods of lining.

The source of the acid liquor is either sulphur or pyrites, burnt in suitable ovens, the fumes being led into towers ("acid towers"), where a constant well-distributed supply of water flows over and through columns of basic material (calcined magnesia or lime) or a milky mixtureof the latter agitated in special apparatus, the reaction in both cases resulting in bisulphite of lime, which collects at the bottom of the tower; from here it is led to the digesters (1,400 to 1,800 cubic feet capacity), in which the wood chips have been steamed before for five or six hours to soften them. The digesters, either stationary or rotary, are now filled up, nearly, with the bisulphite and the temperature raised to 225° and after a certain stage to 265°, at which it is kept until near the close of the process, when it drops again to 220°, the boiling lasting for thirty to fifty hours. The liquor is then drawn off, the acid washed out of the pulp in vats under constant agitation, sifted, drained, and dried.

While the lime needed in the process is found almost anywhere—magnesite, which is found in California, and the dolomites, which are found more generally, and react more readily—the sulphurous constituents are not as easily obtainable. The supply of sulphur for the United States comes mainly from Sicily, although sulphur mines are opened in Utah near Salt Lake and in Humboldt County, Nevada (Rabbit Hole Mountain). Pyrite ores, which form the principal native source of sulphurus acid, are mined at Capleton, Connecticut ; Elizabeth Mine, Vermont ; Rowe, Massachusetts ; Mineral City (formerly Tolersville), Virginia; and several localities in Georgia ; also in Nova Scotia and and on the north shore of Lake Superior (Sudbury), and in the Western States.

It is suggested that the sulphurus products from the roasting of copper ores and of zinc blende ores might be utilized, the latter being found largely in Southwest Missouri (Joplin) and South eastern Kansas (Galena), Southern Wisconsin and Illinois (La Salle). It is also suggested that the gas works lime might be worked over for the sulphur it contains.

The residue from the process, sulphate of lime with resin gums, etc., combined, is of no value.

The outlay for mill and machinery in this process is said to range from and $5,000 to $15,000 for each ton of daily product, and the cost of manufacture $30 per ton.

(*d*) *Electro pulp* is a product of most recent processes (developed by C. Kellner), in which the wood is digested in a solution of common salt at 250° to 260°, constantly electrolyzed.

Two digesters in communication are employed and the liquid is kept in continuous circulation from the electrolyzing vessel over the wood in the digesters and back to the electrolyzer, the latter a separate vessel in communication by means of pipes with both digesters.

The electric action splits up the salt into caustic soda and chlor-oxygen compounds; these latter, of well-known bleaching power, make the usual subsequent bleaching unnecessary and the process is said to furnish at once a "snow white" fiber. Under this class of processes belong also those pulping processes which employ chlorine gas as a disintegrator rather than a bleaching agent. The effect of the chlorine gas or its active oxygen compounds is to oxydize the incrusting substances so that they become soluble in very dilute alkali liquors without the need of higher temperatures.

The bleaching is done, as a rule, by the of use of hyposulphite or bleaching powder, which is mixed with the pulp in varying quantities.

Lately an electro-chemical bleaching process (E. hermite) seems to have been brought to perfection, in which a weak (5 per cent) solution of magnesium chloride is electrolyzed. The chlorine developed acts as a bleacher and then combines again with the base, so that the same liquor can be used over and over again, the cost of the motive power for the electric machine being the only expense. The elaborate plant is objected to. (See Journal of Society of Chemi-

cal Industry, London, 1890, containing one paper in vindication (Cross & Bevan), and another against the process (Hurter.) A further improvement of this process consists in adding a small proportion of quicklime to the salt solution, whereby it is claimed the electro-motive force may be reduced and other advantages gained.

To estimate the commercial value of these various processes three points, it seems, ought to be considered: (1) The resulting product as to quality and yield; (2) The cheapness and convenience of the necessary plant and chemicals; (3) The application to various woods.

Ample water power and clear water, supply of suitable woods with large proportion of cellulose, long felting fiber, and requiring least expense in freeing it from incrustations, are the conditions, in addition to those which favor any other commercial enterprises, to be looked for in locating plants. I would especially point out in the interest of forest management and forest supplies that an adaptation of the plant to the simultaneous use of the various woods offered, combining those of long and short fiber, will have to be the study of the future.

The material obtained by the different processes differs in quality and quantity and answers different purposes.

The *ground pulp* is naturally of short fiber, and while without addition of a long, elastic, and felting fiber, only short (brittle) paper can be made from it, for a filling material of better classes of pulp in the manufacture of ordinary cheap paper and cardboard it answers very well, giving body and capacity. Common newspaper consists of 80 per cent of ground pulp.

The yield should be 1 pound per horse power per hour of dry stuff and about 19 pounds per cubic foot of wood where spruce and fir are used. The larger yield reported—namely, 2,000 pounds to the cord—refers either to a very well measured cord or else to material not thoroughly air-dried. The plant is naturally cheap and with pure water and sufficient fall of the same is easily put up and run economically. The wood need not be as clean as for the chemical processes, inferior material being satisfactory, although branch knots must be removed as they discolor the pulp and rotten wood can not be used. The better class of firewood answers very well. All woods can be used for this process, but the harder woods require more power, and hence are less economically worked, so that now mostly conifers are ground; also aspen, poplar, cottonwood, basswood, birch, buckeye, and gum.

The *brown pulp*, which seems not to be made in this country, yields a much longer and better felting fiber, since by the steaming process a part of the incrustation is dissolved and the fibers are loosened, and hence not so much lacerated in the grinding. Since, however, the dissolved compounds impart a dark color to the pulp, it can be used only for brown papers. It makes, however, an excellent, tough packing paper and strong pasteboard. Attempts to remove the brown color by boiling in dilute oxalic

acid have so far been only partially successful. A process by which the wood is boiled in hydrosulphuric alkalis with subsequent washing in hot water seems to be more successful in yielding a whiter material capable of treatment with bleaching powder. The salts can be recovered and used again, while the brown liquor of solved materials may be worked advantageously for wood alcohol, so that this process promises much economy. The yield of pulp under favorable conditions is said to be as high as 70 per cent in weight of the wood, which is the highest claimed of any process.

The chemical processes furnish the best material, but since the chemicals under higher temperatures attack and dissolve part of the cellulose itself, the yield is considerably less than from the mechanical and partly chemical processes. While the electric process is as yet in its infancy, there can hardly be any doubt that it will be rapidly developed and eventually supersede all other processes, since it involves no other expenditure than that for motive power and promises to yield a superior product.

The *soda pulp* is similar to that from cotton rags, of greater softness and opacity than the acid pulps, but the yield is rather low on account of the strong action of the chemicals on the cellulose; thus while the bisulphate may yield 45 to 50 per cent from white pine, the soda process would yield only 33 per cent, or 800 to 1,000 pounds per cord. The present low cost of soda and the easy and cheap method of recovery from the spent liquor by evaporation and calcination, in which latter operation the fuel is supplied by the dissolved organic matter, are factors of economy which may offset the lower yield.

The *sulphate pulp* yields a paper similar in quality to that from soda pulp, perhaps somewhat better, approaching linen paper. The objectionable smell and the economic features of this process have been pointed out before. The absence of tank wastage is particularly noticeable. It is also claimed that it bleaches far better and with half as much bleaching material as other processes in the market. It is probably classed with either soda or sulphite pulps.

The *sulphite pulp* is harder and more transparent than the pulp obtained by alkaline treatment. It may be used without further bleaching for tinted and low white paper, but to produce a fully white material like soda pulp, 15 to 30 per cent its own weight of bleaching powder is required. The yield should be 40 to 50 per cent, but from the reports, it would appear that the practice in this country brings hardly more than the soda process. With the residual liquor and entire loss, and no special features of superiority, it is questionable whether this process, although at present on a boom and enormously extended, will ultimately maintain its high position, especially when it is considered with reference to wood supplies, it cannot be expected to supersede the alkaline processes.

ADAPTATION OF WOODS.

The soda and sulphate processes can utilize *much more resinous* and knotty woods or parts of trees because the resins combine with the alkalis to form soaps soluble in water and hence easily washed out, while the acid processes, like the sulphite, dissolve the resins only partially, and are, therefore, perferably used for young growth and sapwood, leaving the older heartwood intact, although it is claimed that the knots in spruce and balsam fir soften as readily as the rest of the wood; but the heart of the Norway pine and probably of the more resinous pines of the South would not yield to this treatment.

The fibers of conifers resemble those of cotton, are of considerable length, flat, tape-like, and flexible, which characteristics impart to them superior felting quality.

The deciduous woods are *most readily acted* upon by *the solving* liquids, and some of them, poplar, aspen, tulip, and basswood, especially excel by their white color; they would, therefore, form a most desirable raw material if their shorter fiber were not objectionable. The cells being in the average only about one tenth of an inch in length, tubular and pointed, they do not make a *good felting pulp*, although they are quite flexible, and hence even the chemical pulp of these woods, with few exceptions, is used only as filler. A further study of our native hard woods, with reference to their fiber, is, however, still desirable before classing them all as second for pulp material.

The poplars, which have the longest fibers of those so far used, have the advantage of a persistent white color, while basswood, next in value, takes a *reddish tint, birch a pink, and maple a purple hue*, which makes it objectionable; larch is said to color very badly. Spruce, balsam fir, hemlock, jack pine, cedar in the North, loblolly pine, and cypress in the South, are at present staples. The spruce especially furnishes at present the bulk of pulp manufactured in this country, a frequent practice being to add some poplar or aspen pulp for the purpose of whitening the spruce pulp.

It is said that trees twenty-five to thirty years old are best for grinding, that evenly grown wood is the most desirable, and that trees from marshy ground are not acceptable. The wood must be freshly cut, as too much exposure to the air hardens the fiber by drying. By keeping the wood in the water until ready to use it, not only is it kept softer, but some of the resinous substances are leached out.

If prices give a correct estimate of values, the chemical pulp is about two and two thirds times superior to mechanical pulp. For the sake of comparison the following quotations are here given:

	At London.	At New York.	Domestic.	Tariff.
Ground pulp (pine), dry, per ton..	$24.00	$30.00	....	....
Ground pulp (aspen), dry, per ton.	40.00	35.00	$26.00- 28 00	$2.50
Brown pulp, dry, per ton.........	30.00	....	....	....
Soda unbleached..................	*$50.00-60.00*	$54.60-61.00	....	6.00
Soda bleached....................	67.50	70.00-78.00	70.00- 75.00	7.00
Sulphite unbleached	50.00-75.00	54.00-71.00	75.00- 80.00	6.00
Sulphite bleached................	82.00-88.00	85.00-95.00	90.00-100.00	7.00
Wood flour.......................	....	27.00	30.00	....

Making the average yield per cord 1,700 pounds for ground, 1,000 for sulphite, and 800 for soda pulp. By the different processes the value of a cord of wood may be brought to $24.50 or $30, respectively.

From the compilations of the Paper Trade Journal (Howard Lockwood, New York), the growth of the industry for the last nine years can be learned:

Growth of daily capacity of running wood pulp manufacture.

	Chemical. fiber.	Ground wood pulp.
	Pounds.	*Pounds.*
1881	259,500	484,300
1883	466,000	633,450
1884	576,000	795,550
1885	587,000	835,830
1886	537,000	960,600
1887	602,000	1,065,900
1888	617,000	1,594,500
1889	666,500	2,407,600
1890	1,075,500	2,990,700

This would show that the business has increased nearly *500 per cent in the last eight years* and nearly 200 per cent in the last four years.

In 1888 the stumpage consumed for pulp was valued at $2,235,000. The product, 225,000 tons ground and 112,500 chemical pulp, was valued together at $12,375,000, the capital employed being estimated at $20,000,000. The figures given below would indicate a present consumption in round numbers of 1,000,000 cord of wood per annum. When it is considered that about 1,000,000,000 pounds of book and news paper are consumed annually in this country, two thirds of which might be made of wood fiber, there is still a considerable margin for this use alone to be supplied by wood pulp.

In reply to the question what the Department might do for the pulp makers' interests, the need of stopping the firing of the woods is most prominently mentioned. The planting of trees, bounty for such planting, or distribution of plant material, are also suggested. Railroad facilities, tariff protection, and reports giving reliable information are asked for by others.

Statistics of the wood pulp industry of the United States, 1890.

(*a*) NUMBER OF MILLS IN OPERATION AND THEIR CAPACITY.

States.	Mechanical (ground) pulp.			Chemical (soda) fiber.			Chemical (sulphite) fiber.			Mechanical and chemical combined.		Total.	
	Number of Mills.	Capacity, daily.		Number of mills.	Capacity, daily.		Number of mills.	Capacity, daily.		Number of mills.	Capacity, daily.	Number.	Capacity.
		Range in 1,000 pounds.	Total.		Range in 1,000 pounds.	Total.		Range in 1,000 pounds.	Total.				
Maine ..	15	2.5-70	407,500	4	20-52	149,000	5	16-30	106,000	..	..	24	662,500
New Hampshire ..	15	4-30	220,500	2	60	60,000	1	10	10,000	..	..	18	290,500
Vermont ..	17	2-80	263,500	..	..	..	1	8	8,000	..	..	18	281,500
Massachusetts ..	3	4-10	21,000	1	11	11,000	3	8-20	43,000	1	40,000	8	115,000
Connecticut	..	..	..	..	..	..	1	..	11,000	..	..	1	11,000
New York ..	67	1.5-80	855,800	4	8-55	117-000	3	16-30	76,000	1	6,500	75	1,055,300
Pennsylvania	3	6-20	42,000	7	6-80	233,000	1	..	25,000	..	..	11	300,000
Delaware ..	..	..	..	1	44	44,000	..	..	..	..	..	1	44,000
Maryland ..	1	25	25,000	1	27	27,000	1	..	20,000	..	..	3	72,000
Virginia ..	2	12-18	30,000	..	..	..	..	..	..	..	..	2	30,000
West Virginia	3	30-30	*84,000*	..	..	..	1	..	*50,000*	..	..	4	*134,000*
North Carolina ..	3	..	7,000	..	..	..	..	..	..	..	..	3	7,000
South Carolina ..	1	..	2,000	..	..	..	..	..	..	..	..	1	2,500
Georgia ..	5	6-4	11,850	..	..	..	..	..	..	..	..	5	11,850
Kentucky ..	1	..	22,000	..	..	..	..	..	..	..	..	1	22,000
Ohio ..	2	8-10	30,000	1	..	7,500	2	..	30,000	..	..	5	67,500
Indiana ..	11	1.5-40	129,500	1	..	30,000	..	..	..	..	..	12	159,500
Michigan ..	8	3-24	67,000	1	..	8,500	4	4-30	72,000	..	..	13	147,500
Wisconsin ..	21	6-30	310,000	..	..	..	5	..	74,000	..	..	26	384,000
Minnesota ..	2	2-20	22,000	..	..	..	..	..	..	..	..	2	22,000
Oregan ..	2	8-40	48,000	..	..	..	1	..	20,000	..	..	3	68,000
California ..	1	..	40,000	..	..	..	..	..	..	..	..	1	40,000
Total ..	183	.	2,649,150	23	..	687,000	29	..	545,000	2	46,500	237	3,927,650

NOTE.—In addition to the above 237 mills, which number represents nearly all at present in operation, there are reported 14 idle and 2 abandoned. From Canada 33 pulp mills are reported, 24 of which have a daily capacity of 276,800 pounds.

(*b*) SUPPLIES AND PRODUCT.

States.	Numbero f mills.	Kinds of wood used.	Range of yield, per cord, in hundreds of pounds.			Number of miles reporting suppplies.					Remarks.
			Mechanical.	Soda.	Sulphite.	Good.	Fair.	Limited.	Declining.	Poor.	
Maine ..	12	Spruce only or chiefly.	16-20	..	11-13. 5	20	1	..	..	..	
	7	Spruce and poplar ..	15-20	10	....	..	..	..	..	..	
	1	Spruce poplar and pine	....	..	....	..	..	..	..	..	
	1	Poplar ..	....	10. 3	....	..	..	..	..	..	
New Hampshire.	13	Spruce only or chiefly.	18-24. 5	..	10	11	2	2	..	..	1 gets supplies mostly from Canada.
	2	Spruce and poplar ..	....	16	....	..	..	..	..	..	2 get supplies partly from Canada.
Vermont ..	11	Spruce only or chiefly.	18-20	..	....	11	..	4	1	1	1 gets supplies mostly from Canada.
	5	Spruce and poplar ..	20-23	..	....	..	..	..	..	..	
	1	Poplar and pine ..	20	..	....	..	..	..	..	..	
Massachusetts	4	Spruce only or chiefly.	15-22	..	10	5	..	..	..	3	2 supplies from Northern Vermont & New Hampshire.
	4	Spruce and poplar ..	17-18	..	....	..	..	..	..	..	

Statistics of the wood pulp industry of the United States, 1889—Contd.

(*b*) SUPPLIES AND PRODUCT.—Continued.

States.	Number of mills.	Kinds of wood used.	Range of yield, per cord, in hundreds of pounds. Mechanical.	Soda.	Sulphite.	Number of mills reporting supplies. Good.	Fair.	Limited.	Declining.	Poor.	Remarks.
Connecticut.	1	Spruce ..	..	..	..	..	..	..	..	1	Supplies from New Brunswick and Nova Scotia.
New York ..	52	Spruce only or chiefly	15-22	..	13	34	7	8	2	2	1 supplies mostly from Canada. 15 supplies from Canada or distant points.
	4	Spruce and poplar ..	16-20	..	..	..	..	..	..	..	
	1	Spruce and hemlock ..	..	..	11	..	..	..	..	..	
	1	Spruce, hemlock, bass	..	..	10	..	..	..	..	..	
	2	Spruce, poplar, & pine	..	..	..	..	..	..	..	..	
	2	Poplar ..	14	9	..	..	..	..	..	..	
	2	Poplar, bass pine, and spruce	..	10	..	..	..	..	..	..	
	1	Spruce and pine ..	..	..	..	..	..	..	..	..	
Pennsylvania	2	Spruce only or chiefly	19-20	..	..	1	..	1	..	..	
	1	Spruce and poplar ..	..	..	10	..	..	..	..	1	Supply from West Virginia and Nova Scotia.
	2	Poplar ..	..	10	..	..	..	..	..	2	Supply from Maryland and Virginia.
	2	Poplar, bass, pine ..	..	9-10	..	..	2	..	..	..	
	2	Poplar, bass, pine, maple	..	7-12	..	..	2	..	..	..	
	1	Hemlock, pine, beech, bass	..	10	..	1	..	..	..	..	
	1	White pine ..	16	..	..	1	..	..	..	..	
Maryland ..	2	Spruce only or chiefly.	18	..	10	1	1	..	..	..	Spruce from West Virginia and Canada.
	1	Poplar ..	..	10	..	1	..	..	..	..	
Delaware ..	1	do ..	..	..	..	..	..	1	..	..	
Virginia ..	2	do ..	20	..	..	2	..	..	..	..	
West Virginia	4	Spruce only or chiefly	17	..	10-5	2	2	..	..	..	
North Carolina.	2	Pine ..	10	..	..	..	2	..	..	..	
South Carolina.	1	Cypress and gum ..	..	..	..	..	1	..	..	..	
Georgia ..	3	Pine ..	20-27	..	..	3	..	..	..	..	
	1	Cypress and gum ..	..	..	..	1	..	..	..	..	
	1	.. .. ..	..	..	..	..	..	..	..	..	
Kentucky ..	1	Spruce, buckeye, and maple	18	..	..	..	1	..	..	..	
Ohio ..	2	Spruce only or chiefly	17	..	..	2	..	..	..	..	
	1	Cottonwood and bass	..	9	10	..	1	..	..	..	
Indiana ..	3	Aspen ..	16	..	..	1	..	1	..	1	
	1	Spruce and poplar ..	16	..	..	..	1	..	..	..	
	2	Poplar, spruce, pine ..	12	..	..		..	1	..	2	
	1	Aspen, poplar cottonwood ..	10	..	..	..	..	..	..	1	
	1	Cottonwood ..	20	..	..	..	..	1	..	..	
	1	Basswood ..	..	9	..	1	..	..	..	..	
Michigan ..	4	Spruce only or chiefly.	16	..	8-10	1	2	..	..	1	1 supply all from Canada.
	3	Poplar ..	16-20	15	..	2	..	1	..	..	
	4	Poplar, pine, tamarac, spruce, and balsam	..	..	..	4	..	..	..	..	
	1	Aspen, pine, poplar, spruce, and bass ..	14	..	..	..	..	..	1	..	
Wisconsin ..	4	Spruce only or chiefly	16-18	..	9-10	1	2	..	1	..	
	15	Spruce and poplar ..	13-15	..	9-10	5	5	2	1	2	
	4	Spruce, poplar, pine ..	10-12	..	..	1	..	1	2	..	
Minnesota ..	1	Spruce only or chiefly	15	..	..	..	..	1	..	..	
Oregon ..	1	Cottonwood ..	..	..	..	1	..	..	..	..	
California ..	1	Tarmarac and fir ..	17	..	..	1	..	..	..	..	

THE ELECTRICAL PLANT OF *INDIA*.

Page 422. Mr. Gamble speaks with wise caution of this, but I fear "Iron" had extremely little "assurance of the *bonâ fides* of its author." The paragraph, I suspect, to be simply "padding" of the big gooseberry and Sea Serpent order, such as goes the round of the papers in turn. At any rate, I remember seeing it, in exactly its present form, months ago, quoted as from one of the French illustrateds. It struck me at the time as being a typical specimen of the Gallic genius in the purveying of intelligence for a *gobemouche clientèle*. *But still*, once more, there may be something, *just* enough to swear by, in it. The "umbrella" is delicious.

F. GLEADOW.

INDIA-RUBBER TRADE ON BURMA FRONTIER.

The India rubber trade was first brought to the notice of the Local Government so far back as 1873, and its exports to the Lower Provinces did not commence till 1870, when the monopoly was leased under the Burmese King to Chinese firms who superintended the work. The sale then averaged from Rs. 90,000 to 100,000, but under the present *régime* the annual outturn is improving and the industry is becoming more important. The forests producing India-rubber occupy an extensive Kachin district north of Mogoung, and stretching east across the Chinese border, and the importance of this industry was first reported by Mr. Warry of the British Consular service in China. The Kachins were at first extremely jealous of interference with their trees, and although they at first made a mistake of over-puncturing them, they are more careful now. Trees may even, at the present time, be seen punctured to the tenderest branches, but they do not appear to be drained to the extent of half their yielding power. Mogoung is the central town of the industry; four-fifths of the annual supply is brought in there by Kachins in the employ of the Chinese lessees; the remainder is purchased by the agents on the spot. The practice is for the lessees to make liberal advances to the Kachins to meet their expenses during the collecting season; and when the produce is brought in, refund is made by selling the rubber to the manager at half the market value. The Kachins, as a rule, are not very honest in their dealings, as they generally place stones inside the rubber balls to obtain a better weight; but better inducements offering lately they are bringing in purer rubber to the market. It has also been found that the travelling agents of the lessees are very dishonest in cheating the producers by decreasing the weight as much as 60 per cent, and as the Kachins have no standard weight, these agents benefit considerably. Before the British occupation, the transit of rubber was subject to a tax by the chieftains of the different States through which the commodity passed, generally 10 per cent (*i.e.*, ten balls were given for every 100 conveyed), but now things have changed, and an *ad valorem* rate of 10 per cent on the value is charged. The Kachins are very particular as to the right of extracting the rubber from their forests; and, as an instance of this, some 200 Chinese labourers were brought in by the lessees two years back, with the result that the Kachins started burning the forests and driving out the intruders. The trade is now yearly flourishing, and the revenue derived is increasing; the produce of the past year was 2,834 bags more than the previous one. (*Indian Agriculturist*).

PADOUK, AS AN ORNAMENTAL WOOD.

Our attention has been called to a very fine specimen of work in Padouk—a dado running up the side of the stone staircase in the new building, 45, Fenchurch Street, built by Messrs. Colls & Son, of Coleman Street, architect, Edward B. Ellis, Esq., 9, Fenchurch Street, E.C. We do not remember to have seen it used for this purpose before, at all events, not for public staircases in City offices. It is a fine piece of panel work, finished in masterly style and with great effect. The figure in the panel comes up very finely under the polish, its tone and colour being rich and beautiful. The hand-rail is also of the same wood, for which it is well suited, being of deep colour, close grained, and durable. This part is not yet completed or polished, but will be as soon as the labour trouble is over. We believe the wood is more expensive to work than ordinary mahogany, but it amply repays, by its unique appearance, the extra cost of working it. Padouk (*Pterocarpus indicus*) comes from the Andaman Islands, which lie on the east side of the entrance to the Bay of Bengal. The tree grows to a very great height and large dimensions. The heart-wood is dark red, close-grained, moderately hard, and takes a fine polish ; it is suitable for furniture, internal house decoration, and numerous other purposes, for which the above qualities recommend it.—"*Timber Trades Journal.*"

MANUFACTURE OF WOOD PULP IN SWEDEN.

The manufacture of wood pulp as a natural product of the country has of late become one of the most important trades of Sweden. At present according to the last report of the British Consul at Stockholm, there are more than 120 wood pulp factories in Sweden, about half of which have been started during the last three years. During 1889 alone, 34 new factories were established. The export of the whole of Sweden, which in 1872 only amounted to 114,000 cwt., amounted during 1889 to more than 938,000 cwt. The prices have been constantly declining, but new and improved methods in a like proportion lowered the working cost, and several factories have shown excellent results during recent years. A great number of the factories have been started at places where the iron manufacture has proved a failure. The present improvement in the iron trade, and the large increase for the price of charcoal, may, however, cause a decline in the wood pulp trade. On the same subject the Consul at Gothenburg observes that the trade is not at present in a healthy state, and the future is seriously endangered by over-production and consequent severe competition. The very favourable position this trade originally held, gave rise to over-production

and decline of prices. This statement, however, is principally applicable to mechanically made wood pulp. The price of chemical wood pulp is still in favour of makers, and the mills that produce this article are well employed. Gothenburg is the principal place of export.

WOOD PULP, EKMAN'S PROCESS.

The manufacture of wood pulp by Ekman's process for paper making is carried on at Bonne-Nouvelle, in Dieppe. The pulp is sold to paper mills in France, and mostly used, together with rags, for the manufacture of various kinds of paper. It is said that the pulp not only produces good printing paper, but also that a high class of writing and other superior kinds of paper can be manufactured from it without the addition of rags. The wood from which it is made is the usual white wood from Sweden and Norway, or Finland. The first operation is to remove the bark and clean the outside of the wood, which is done by women who have been found more suitable for this work than men. Afterwards the round logs are cut into flat pieces of about 2½ inches in thickness. The knots are now, as far as possible, bored out by machinery, but any that remain are cut out by hand. Great attention is paid to cleansing the wood in order to obtain a pulp clean enough for good kinds of paper. The clean wood is fed into a cutting machine which rapidly cuts it up into pieces of about 1½ inch in length. A band carries the cut wood to the top of the boiling-house. The boilers are of iron, covered on the inside with lead to protect the iron from action of the sulphurous acids used. The boilers are filled with wood from an opening in the top, and then a liquid containing bi-sulphate of magnesia is poured in to cover the wood. The boiler is then closed with a cover, and boiling is done with steam, the time varying from ten to twelve hours. When the boiling process is finished the steam is blown off, and the pulp forced out through a valve at the bottom of the boiler into a tank with a perforated bottom, to allow all the liquid to drain off. The process used is known as Ekman's sulphite process. The chemicals, a solution of bi-sulphate of magnesia, are prepared by leading the gases from burning sulphur over magnesite, water being admitted at the same time. The magnesite—carbonate of magnesia—is a kind which is found in large quantities in Greece and imported from there. (*Indian Agriculturist.*)

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A NEW SYSTEM OF TEMPORARY DAM.

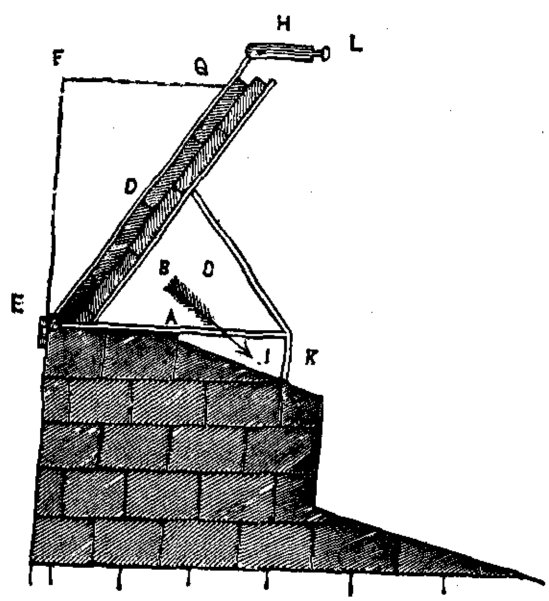
The translation which follows is forwarded as it is thought that the idea may be useful in some parts of India where irrigation or other water-supply is dependent on raising the water-level by a few feet during the drier months of the year. The only indispensable point appears to be a masonry wall crossing the direction of the flow and this may be below the ordinary water-level so as to be unaffected by floods. The system seems to recommend itself by efficiency, cheapness, ease of erection and the readiness with which the material can be stored.

S. E. W.

In 1867, having occasion to irrigate some meadow lands, I found myself posed by the following problem—"To increase the height of a permanent masonry weir by erecting a temporary structure upon it without tampering with the masonry or driving nails into it." This problem was sufficient to cause me grave consideration, for I had been informed by scientific men that it could not be solved, and moreover I knew that its solution had not been attempted either in theory or practice. I had nothing to support my temporary dam, but the surface of the weir and the water it was desired to retain. Without being discouraged, however, I set to work with, as basis, that law of hydrostatics which fixes the point of and direction of, some of the angles of pressure of a liquid on a surface; and also the laws regulating the equilibrium of a solid body resting on certain fixed points; and after various gropings I arrived at the desired result. This result is attained by

(Translation from the French of Dr. Villeneuve in the "Révue des Eaux et Forêts" of April, 1891.)

inclining the surface of the moveable obstruction to the water in such a manner that the sum of the angles of pressure follows a line which passes inside the points of support of the moveable barrier. The solution of the problem appears to me to be novel both in theory and practice, so that when it has been worked out by the Forest or other scientific departments, the theory may well be extended beyond the humble issue I had in view and perhaps become the basis of a new system regulating the construction of temporary dams and applicable to much larger works, besides resulting in various advantages, economic and otherwise, over the systems now in force. The first application of the system was made to a weir in the river Ignon twenty-two years ago, and this has worked well ever since and is still in good order, so that it may be fairly said that practice has proved the value of my theories and of my system. The drawing below represents a transverse section of the arrangement.



The apparatus consists of iron frames and planks. The former are placed on the top of the weir and at about 5 or more feet apart. The 3 iron bars A, B, C, are welded together, the fourth bar D, being hinged at E, can thus be moved from G to F, in order to facilitate the introduction of the planks. This bar D, is also provided with a hinged collar H, which is furnished with a clamping screw L. At one end of the bar A, there is a rigid hook

which passes over the face of the masonry weir; at the other end is a pedestal K, of such a height as to rectify the slope of the top of the weir. The object of the bar B, is to support the planks which are placed in the space between B and D, and the bar B, must be fixed at such an angle that the line of pressure of the retained volume of water passes along the arrow I, in the inside of the pedestal K. The whole success of the system depends on the accuracy of this item. The planks, well planed on the edges, should be of such length as to overlap at each end and of breadths convenient to the proposed height of the dam. The iron frames are then placed in the weir in a line and so far apart that the planks may overlap in the spaces between B and D, the planks are inserted, the bar D closed and the collars at H tightened up; it will of course be necessary to insert a plank of the same thickness longitudinally at the terminal frames to make up the space between B and D, where there will be no overlaping planks. So soon as the pressure of the accumulating water is brought to bear on the barrier, it acquires an incredible firmness and stability. Contrary to what would be imagined, the hooks *at E, serve only to correct the alignment of the frames and* to resist the sudden shock caused by any drifting body brought into contact with the dam; in fact if the hooks be placed quite clear of the masonry, the pressure of the water alone will never drive them home. The temporary Dam constructed by me is about 50 feet long, by 2 feet high; it cost £4 10s. and can be put in working order in 15 minutes by one man.

DURABILITY OF RAILWAY SLEEPERS.

We have received the usual statement shewing the renewals of wooden sleepers on State Railways. It is well known that experiments are in progress on many of the Indian Railways to test the durability of sleepers. The results of some of these experiments up to the end of 1889, will prove of general interest. On the Rajputana-Malwa Railway, 2,054 deodar sleepers were laid down in 1876, and at the end of 1889, only 131 had been removed thus shewing that the life of a deodar sleeper on this Railway is at least 13 years; although the *average* durability cannot be ascertained until the last sleeper has been removed, we already know that it will exceed 13 years.

Similarly, out of 689 teak sleepers, 110 were removed at the age of 12 years; and out of a lot of 6.318 pine, 4,112 had gone at various intervals, giving an average age of 10 years. The celebrated *Hardwickia* has lost 431 sleepers out of a total of 902, at an average age of 12 years. On the North-Western Railway, out of 600 deodar sleepers laid down in 1877, only 21 had to be removed up to the end of 1889; and of 275 creosoted pine, 31 had been removed in the same time. In another experiment on the same Railway, between Lahore and Karachi, 1,016 deodar and 382 creosoted pine sleepers, laid down in 1877, were still in use 12 years afterwards. This result, possibly due to the dry climate, is *even more favourable than the one first* quoted.

On the Eastern Bengal Railway, 1,973 sal sleepers were laid down in 1877. During 13 years, 514 had been removed at an average age of 9 years. Creosoted pine during a similar period, had lost 1,755 out of a total of 1,923, the average age so far having been 8 years. On this railway, experiments are being carried on with ironwood also, but they are of too recent an inception to furnish any tangible result.

So many factors enter into the question of the durability of railway sleepers, such as climate, ballast, traffic, seasoning of the sleeper before being laid down, &c., that it is almost impossible to draw any useful comparison between the results of these experiments, and it will be as well to await their completion before attempting it. This much however is clear, that deodar is likely to hold its own with any of its competitors, a gratifying result for those who have the management of deodar forests.

A. SMYTHIES.

FORESTRY IN JEYPORE.

We have received the *Progress Report of Forest Administration of the Jeypore State for 1890*, and first of all it seems to us strange that they must insist on being in the fashion as regards lateness of issue. Instead of 1890, it ought to have been 1891, for a Native State Report, at most, requires a short review by a Resident or State Engineer, instead of, as happens in Indian Government Provinces, some two or three (the unfortunate Madrasis have *three* successive reviewers, all keen to discover their weak points,) official reviews of various lengths.

Bhai Sadhu Singh, the present Superintendent, is a Punjab Forest Ranger, who has been lent to Jeypore and we are glad to see that Colonel Jacob speaks well of him and that a Dehra Dún student has been able to run the forests of Jeypore "with credit to himself."

There is not much to note in his report: "no news is good news" is a proverb which might often he well applied in the case of annual reports where an officer is looked upon in some quarters as of little use if he has not some startling event to record or some new departure to announce.

Here there is nothing much to disturb the even tenour of gradual progress, though, as elsewhere, "grazing privileges" seem to be the crumpled rose leaf of the Jeypore Forest Department. No less than 8,932 goats and sheep and 1,472 head of cattle were impounded during the year, chiefly owing to the refusal of villagers to obey new rules requiring fees for goat grazing.

The area of "Reserved Forest" in Jeypore is now about 228 square miles in all about half being demarcated. The revenue amounted in 1890 to Rs. 19,869; and the expenditure, all told, *i.e.*, including avenues, grass preserves and other extra charges, Rs. 16,714, so that there was a surplus of Rs. 3,155. The State Engineer omits the extra charges and consequently quotes the surplus as Rs. 4,954. We wish the Jeypore Forest Department, the first we believe, except, of course, Mysore, of the kind in a Native State, every success, and we are glad to think that the lessons of the Dehra Dún School, have proved useful to the Superintendent of Forests in charge.

We have received Government of India Circular 13F of May 12th, 1891, giving the following figures for the Budget Estimate of the Forest Department for the year, it will be noticed that a surplus revenue of over sixty lakhs is expected.

ESTIMATE OF REVENUE AND EXPENDITURE 1891-92.

	REVENUE.			EXPENDITURE.		
	BUDGET ESTIMATE, 1891-92.			BUDGET ESTIMATE, 1891-92.		
	Imperial.	Provincial.	TOTAL.	Imperial.	Provincial.	TOTAL.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
India, General	4,44,000	...	4,44,000	4,53,000	...	4,53,000
Central Provinces	6,51,000	6,51,000	13,02,000	4,60,000	4,60,000	9,20,000
Upper Burma	16,50,000	...	16,50,000	4,12,000	...	4,12,000
Lower Burma	13,00,000	13,00,000	26,00,000	6,63,000	6,64,000	13,27,000
Assam	1,90,000	1,90,000	3,80,000	1,46,000	1,46,000	2,92,000
Bengal	3,90,000	3,90,000	7,80,000	2,34,000	2,35,000	4,69,000
North-Western Provinces and Oudh	8.52,000	8,53,000	17,05,000	5,29,000	5,29,000	13,58,000
Punjab	4,75,000	4,75,000	9,50,000	3,63,000	3,64,000	7,27,000
Madras	...	18,00,000	18,00,030	...	13,40,000	13,40,000
Bombay	17,50,000	17,50,000	35,00,000	10,15,000	10,15,000	20,30,000
Total ...	77,02,000	74,09,000	1,51,11,000	42,75,000	47,53,000	90,28,000
England	...	...	...	21,000	...	21,000
Exchange	...	...	...	8,000	...	8,000
GRAND TOTAL ...	77,02,000	74,09,000	1,51,11,000	43,04,000	47,53,000	90,57,000

THE JUTE CROP OF BENGAL.

The following report on the prospects of the Jute crop has been received from the local Government :—

"The principal factors which affect the area sown under Jute in any particular year are the highness or lowness of the price of Jute in itself, and as compared with the prices of the other staples during the preceding year, and the climatic conditions before and at the time of sowing.

"A rise in the price of Jute, if not accompanied by a general rise in prices of other staples in the jute-growing districts, would obviously tend to stimulate the extension of cultivation of jute; while a fall in the price of this particular product, without a corresponding fall in the prices of other staples, would have the opposite effect. During last year there was a great falling off in the price of jute as compared with the previous year; while the price of rice, its chief rival in the jute-growing districts, was nearly the same as in the previous year. The effect is generally reported to be a contraction of the area sown in the present season under jute.

"*Climatic conditions.*—The climatic conditions most favourable to the cultivation of the plant are when light and frequent showers fall before and at the time of sowing, which extends from the middle of March to the first week in June, commencing earlier in the northern and eastern districts and later in the central districts of Bengal. Last year the rainfall during these months was sufficient and well distributed in almost all the jute-growing districts, and this fact, combined with the high prices of jute prevailing in the previous year, caused an increase in the area sown. The present season has not been so favourable. After heavy rain which fell about the middle of March last, there was practically no rain in Bengal until the end of the third week in April. The want of rain, at this time, is reported to have caused a contraction of the area sown in Jalpaiguri and Purneah. From the 21st of April to the second week in June, the rainfall was, on the contrary, abnormally heavy throughout the jute-growing area with the exception of the districts of Hooghly and Khulna. This excessive rain is reported to have impeded the sowing and curtailed the area under jute in the 24-Pergunnahs, Dinagepore, Rajshahye, Bogra, Furreedpore, Dacca and Tipperah; and is likely to have reduced the area also in Nuddea, Jessore, Rungpore, Pubna and Mymensingh.

Outturn per acre.—After the plants have struck root and until harvest time, moderately heavy showers, followed by sunshine, are needed for the full development of the plant. Frequent intervals of fine weather in June are necessary to enable cultivators to carry on weeding operations. In the present season the excessive and constant rainfall in May and the early part of June, not only impeded the sowing, but also interfered with the germination and growth of the crop at the beginning, and afterwards hindered the weeding operations in all the districts of Northern and Eastern Bengal and 24-Pergunnahs. The extent of damage due to this cause is reported to have varied from two to six annas. It is premature to form an accurate estimate of the outturn. Much will depend on the distribution of rainfall in July and August. So far as it is now possible to forecast, it may be said that the outturn per acre will be less than that of the previous year by two to four annas. The area under cultivation is reported to be about 18 per cent. less than that of last year. In the forecast of last year it was said 20 per cent. more than in the previous year would be available for export. According to that estimate, the quantity available for export would be 10,522,768 cwts. The quantity actually exported was 10,606,145 cwts. As already remarked it is premature to form anything like an accurate estimate of the present year's gross outturn, but on the whole it appears probable that the quantity available for export will not be more than three-fourths of that of last year."

THE PROGRESS OF WOOD PAVING.

When the first wood blocks were laid in London, some twenty five or thirty years ago, want of experience entailed enormous expense, owing to defective foundations, employing the wrong sort of wood, cutting the blocks to the wrong dimensions, and laying them badly. Thus a general impression was created that as a practical pavement wood could never take the place either of macadam or granite.

It was found that the blocks got quickly misplaced, that they wore with great irregularity, and that streets so paved were excessively costly to keep in order. In short, it was considered that, though excellent when first laid down, it would not prove a sufficiently long-lived class of pavement, and would be too expensive for it ever to become a commercial success on a large scale.

But, though this was the general impression, there were people who saw further in the matter, who considered that great advantages would accrue from its adoption if the difficulty of excessive wear and tear could be satisfactorily overcome. The surveyors of certain of the vestries and others decided that it would be worth while following the matter up and expending a considerable amount of money in endeavouring to bring about the desired result. For many years after the first essays wood paving met with but little success and no encouragement. Every imaginable system of foundation was tried, from placing the blocks on cast iron plates, to laying them on wooden boards, or on the road itself without foundation, until at last the system, which is now universal, of laying them on a 6 in. bed of concrete, was adopted. This proved so satisfactory that ten years ago wood paving had become already an important feature in the metropolis, where many miles of streets were already paved more or less satisfactorily with wood blocks.

In spite of the fact that there were many minor difficulties to be got over, in the way of determining the most economical system of grouting the blocks, of keeping them at a uniform distance apart during the process of grouting, and also making the necessary allowance for expansion and contraction, we learn, in 1884, from statistics gathered together by Mr. George Henry Stayton, and referred to in a paper read by him before the Institution of Civil Engineers, that no less than 53¼ miles comprising nearly 1,000,000 square yards of the streets of London, were already paved with wood at that time, and that as compared with the ordinary macadam road, when taking a period of 20 years

and calculating on the average practical results of wood paving up to that date, the laying and keeping in repair of wood paving amounted to less than 2s. per square yard per year, whilst the annual cost of maintaining and cleaning a macadam road of similar dimensions and with similar traffic was very nearly 3s. per square yard, and with regard to the macadam road no first cost is included in the price of 3s. per annum.

From the fact that nearly 1,000,000 square yards of streets in London alone were paved in wood in 1884, it may be presumed that by that time, at all events, the system had got beyond its experimental stage, and was already recognised as practical.

Between that year and the present time, though statistics are difficult to obtain, it may be readily assumed that the mileage of wood paving in London has been more than doubled, and it has been proved that with its extension, the cost of laying and maintaining has been reduced, whereas the cost of macadam road has remained the same. Thus the laying and maintenance of a wood paved street, which, in 1884, cost nearly 2s. per yard per annum, now costs less than 1s. 6d. At the present date the making of wood blocks has become an industry of itself, and large plants of special sawing machinery are devoted merely to the production of the blocks. To give an impression of its importance at the present day, we would mention that one large firm alone is stated to be in a position to turn out as many as from 20,000,000 to 30,000,000 wood blocks in the course of a year. Through turning out the blocks by means of improved methods, and by systematising the labour, the cost of maintaining, including the necessary re-laying has been able to be reduced as above stated.

It is a strange fact that, the more important the thoroughfare, the longer, as a rule, is the life of the wood paving, as the passage of traffic over the blocks has the reverse of a deteriorating effect on them, in that it prevents their rotting.

Of the great variety of woods which have been tried, pitch pine is considered all round the most serviceable quality. Opinions differ greatly as to whether it is good policy to creosote the blocks or not. The advocates of creosoting state that it has great advantages from a sanitary point of view, whereas people who are opposed to this process maintain that the creosoted blocks are apt to rot internally, and also that it is difficult to detect bad wood when its outside surface has been discoloured, and that, consequently, it may lead to defective blocks being used. However this may be, both systems are largely adopted now.

The extension of wood paving has not been confined to England alone, but many of the great cities on the Continent have already taken it up, and its adoption is even spreading to the colonies.

The advantages of wood pavement may be summed up as follows :—

That in price it compares cheaply with other forms of pavement; that it is comparatively noiseless; that owing to its uniformity and a certain elasticity of surface, it causes much less wear and tear to the traffic passing over it, more especially to the lighter class of carriages.

As reported in our issue of the 21st ultimo, the question of extension of wood paving is occupying the attention of the House of Lords, where it has been shown that the London drivers prefer it to either granite, asphalte, or macadam.

Foreign countries which did not adopt the wood pavement until it had become a commercial success, had a great advantage over England, in that they were enabled to profit by our expensive experience. So costly and discouraging, in fact, were the first trials, that it speaks well for wood paving that it has been able to live through the many years of necessarily bad management and unsuccessful experiments, and to gain for itself the position it maintains at the present date, namely, that of being the cheapest and most practical pavement for city thoroughfares where the traffic is regular.—*(Timber Trades Journal.)*

For further information on this subject we would refer our readers to a short article by A. S. in the Indian Forester, Vol. IX, p. 352. When that note was written the principal timber used was yellow Baltic deal, but it would now appear that pitch pine, the *Pinus australis* of Florida and the Southern United States, has taken the place of the Swedish wood.—ED.

WOOD PAVING THE THAMES EMBANKMENT.

At the meeting of the London County Council on Tuesday the following report of the Highways Committee was adopted:—"We have, in connection with the question of the future maintenance of the Victoria Embankment carriageway, considered whether, having regard to the late cost, amounting last year to about £3,100, of remetalling, it would not be advisable to adopt some less expensive surface for the road. We have received from the engineer a report, stating that the annual cost of maintenance of the existing carriageway is 2s. 1d. per square yard, while the annual cost of wood paving for the same area would probably amount to only about 1s. 11¼d. per square yard, including the provision of a sinking fund to repay the cost of the wood in eight years, and of the concrete foundation in thirty years. He further states that when the cost of the foundation shall have been repaid, the cost of maintenance per square yard per year will be reduced by 2½d., and that in his opinion the adoption of wood paving would result in a present saving of £500 per annum in this item. The superficial area of the carriageway of the embankment amounts to 54,500 square yards, equal to a length of four miles of an ordinary 40 ft. road, and the engineer estimates that the

cost of wood pavement for this area would be about £28,250. He *further suggests that if the wood paving* be *adopted*, the work of laying it should be carried out in three sections in three successive years, in order to avoid, as far as possible, a prolonged interference with the traffic, both in the first laying of the pavement and in the execution of repairs, which may become necessary thereafter. Having fully considered these statements and estimates which have been laid before us of the cost of macadam as against other kinds of road material, we have come to the conclusion that it is advisable that wood pavement should be laid on the carriageway of the embankment; and we recommend that, subject to an estimate being submitted by the Finance Committee as required by the statute, the carriageway of the Victoria Embankment be paved with wood, at an estimated cost of £28,250; that *the repayment of the cost of the wood* be *spread over* a period of eight years, and of the concrete foundation over thirty years; that the work be carried out in three sections in three successive years; and that it be referred to the Highways Committee to prepare a specification, and to make arrangements for the execution of the works.

JARRAH WOOD USED IN PAVING.

With reference to jarrahwood, which just now seems to be attracting so much attention, it is worthy of note that its use as wood paving is rapidly increasing, and, as time wears on, it threatens, if not entirely to supersede the ordinary deal for the purpose, at least, as far as the metropolis is concerned, to take its place in many of the leading thoroughfares. When up in the neighbourhood of Westminster Bridge the other day, we noticed that a considerable quantity of street paving work was being done by the Lambeth Vestry, in which jarrah was a principal feature, those who try it evidently approving of it. We invariably find that when an article is able to sustain its character for all the merits those who make it a speciality, claim for it, we may be assured of its ultimate success. Though cheapness is now all the rage, the old lady's remark that she had lived through several generations, but had never known a penny loaf sold for a half-penny, is by no means inapplicable to the present position of things. Good articles will always fetch good prices *when they are wanted.* That is the pith of the whole thing.

We believe that very soon jarrah and similar woods will be wanted, and in quite as large quantities as our Australian friends will be able to supply them. It was thought that this kind of wood from its close texture and density, as with the generality of hard-woods, was likely to prove too slippery for the heavy traffic of London, but experience has so far not borne this out. The approach to Westminster Bridge on the Lambeth side is paved with jarrah, and no complaints on account of its being dangerous

to horses have yet been heard, although the blocks have been down some time, Griffin Street likewise is paved with this wood, and other places in the vicinity, and the Vestry pronounce themselves well satisfied with it, and actually find it a saving on the ordinary wood, from almost everlasting wear. These people are keen enough to their own interests and we may be sure would not go to the extra cost (about treble that of deal,) unless they saw a profit in it. Messrs. Bartram & Co. are at present cutting several barge-loads of jarrah planks into paving blocks for the Vestry, which, we understand, are to be laid down in the long stretch of roadway connecting Waterloo and Blackfriars Roads, commonly known as the New Cut.

There can be very little question that for paving work this particular wood has no rival. The fears that, owing to the hardness, it will not take grit, and in prolonged dry weather become dangerous except on the dead level, ought to have been sufficiently tested by this time as we had an uncommonly long spell of dry weather both in April and May (six weeks without a drop of rain and a fair share of dry throughout September, but the absence of complaints from omnibus drivers is a good sign for our jarrah friends, as with these vehicles, after all, rests the bulk of the street traffic.

WOOD BLOCK FLOORING.

Among the many forms of flooring which have been suggested for the purposes of hospitals, infirmaries, churches, and similar institutions, where noisy footfalls are a "thing not to be desired," wood blocks seem to have attained most general acceptance. Besides being practically noiseless, they are firm and solid to the tread, while their warmth—compared with ordinary boards—has been another factor in their successful competition for popularity. *Like the wood pavement, they are laid up a hard bed of concrete,* thus preventing foul air or vermin to accumulate to the detriment of the healthy conditions of the building. One objection often raised to the system here mentioned is the liability of the blocks being kicked up, but Messrs. Nightingale & Co. have overcome this undoubted disadvantage, and are prepared to guarantee the complete and permanent fastening of the blocks to the prepared surface of concrete bed. This desideratum is obtained by the employment of their "Special Antiseptic Compound." Again, it was feared when the adoption of wood block flooring was first advocated, that it would be almost impossible to avoid hollow spaces betwixt the blocks. *Into these crevices dust and filth, it was alleged, would* fall, and thus keep permanently on the premises one of the causes of infectious diseases. The firm to whom we have referred have also directed their attention to this matter, and as a result, their blocks can be had fitted together with perfectly close joints. Almost every criticism that was once urged against the

superseding of ordinary floors, has been disarmed by Messrs. Nightingale & Co., who, from their Works at Great Grimsby, are sending out yearly increasing quantities of their new and improved wood block flooring. It will be readily seen that in cases of fire the solid floor will have a desirable effect in arresting the progress of the flames. Briefly stated, then, the chief points in favour of wood block flooring are the greater cleanliness which can be obtained, the freedom from noise and consequent annoyance, the lessened risk of the spreading of epidemics, the probable abatement of fire, and the more finished and pleasing appearance presented by the blocks.

Messrs. Nightgingale & Co., have had more than twenty years experience in the handling and seasoning of timber, and hence their judgment as to the best description of wood suitable for the purpose may be deemed reliable. All work executed by them will be found proof against dry-rot and dampness, sap, curling, shrinkage &c., and the floors can be laid in any variety of pattern, herringbone. interlacing, for aisles or corridors, for dining-rooms and large areas, &c. Among the woods generally used are redwood, oak, walnut, chestnut, pines, teak and, if desired, the floors can be stained to any shade at a small cost. The advantage of the latter process is seen in the less frequent washing of the floors that is required and also in the enhanced effect produced.—*Timber Trades Journal.*

PAPER AND PAPER MAKING.

In the early ages of the world's history, and before the discovery of paper-making as it is practised at the present day, the *only form of writing known was that of carving on stone, and the* inscriptions on the Sinaitic Rocks and Assyrian Stones, as well as on the Rosetta Stone, are prominent instances of this. Slabs of wood, papyrus leaves, skins, parchment, and bark of trees, were also used for the same purpose. The elder Pliny, in his "Historiæ Mundi," gives an interesting description of how the papyrus is prepared, and the appearance of it;—its utmost breadth, when put together, was never over 13 fingers, it was white and smooth, being polished with a shell to make it glisten. It is not until the year 1320, however, that we have the first authentic records of paper *having been made on the present principle.*

The first paper manufactured from pulp was from pounded cotton. This is proved by Montfaucon, who discovered manuscripts on this materal written in the beginning of the tenth century. A hundred years later it had become general in the east, and as far west as Sicily. Abbott Petrus Mauricius of Cluny, who flourished 1123, in his "Tracts against the Jews," distinctly states that the books of his day were often made "of rags," mean

ing probably linen rags. This is the first record of paper made on the same system as is now followed.

Cranden, Prior of Ely, in the reign of Edward II. had registration made of certain of his acts, and these, we are informed by the learned Humphrey Prideaux, who was Dean of Norwich in 1702 were seen by him. The Dean also states that he had examined certain wills in the Bishop's Registry at Norwich, all made on paper, and which bore date as early as 1370. We also know that William Caxton produced his books on "paper made of the paste of linen rags, very fine and good, and not unlike the thin vellum on which they used to write their books at the time." This was towards the end of the 14th century, and synonymous with the introduction of paper in Germany. It would thus appear that to England belongs the credit of having first manufactured paper, but as to whom we are indebted for the invention, history is absolutely and sullenly silent.

It is scarcely necessary to state that, up to this point, and indeed until the sixteenth century, all papers were made by hand and in somewhat the same fashion as is still followed in the matter of "Hand-made" paper, though with appliances exceedingly rude and simple.

To the Chinese, however, belongs the honor of having used paper long ere it was known to the Western nations at all. If the use of paper among that strange and changing people, be at all contemporary with their practice of wood-block printing, we may date its introduction to a period at least 1200 years before the Christian era. It has been assumed by several writers that the knowledge of it was brought to Europe from China by the Arabs, who communicated it to the nations of Europe during their occupancy of Spain. This would appear to be incorrect, as it was in the Byzantine Empire that its use arose, and from whence it spread west through Venice and Sicily.

The first paper mill was set up in the town of Hertford, about the middle of the fourteenth century, by John Tate. His *water-mark was an eight-pointed star in a double circle, and it* was used in an important Latin work, "The History of the Properties of Things," by a Franciscan named Glanville, a scion of the noble house of Suffolk. About 1470, an edition of this work was printed by Caxton, the introduction bearing these lines—

> "And John Tate the younger Joye mote he broke
> Whiche late hathe in Englond doo make this paper thynne,
> That now in our englyssh this boke is prynted Jnne.

showing clearly Tate's connection with it.

This mill was well known in the time of Henry VIII., for we have it on record that the "Merrie Monarch" paid it a visit, and there parted with eight shillings of his money "to Tate of ye mylne," probably for some paper brought away by him. Henry, with all his faults, encouraged industry in his subjects, and—paid cash down!

It was not till towards the end of the seventeenth century that the first mill was established in Scotland, showing how slow the Scotch were in adopting the invention. Nevertheless vast strides have been made in the trade north of the Tweed, until now the finest paper and the best paper-making machinery finds its way thence to all parts of the world, and not least to the southern portion of the island.

It would be beyond the province of the present sketch to enter on a minute description of the machinery by which paper is made, and indeed most people have seen the process. Suffice it to say that paper-machinery has been changing with the changing times. Up to 1860, paper was entirely made of rags, but the repeal of the Paper Duty and the application of esparto grass for the purpose (which reduced newspapers to a third of their previous price) gave such an impetus to the trade as almost to revolutionise the whole system. Machinery of a high character was introduced suited for the working of the new material and inventors vied with each other in the production of every possible improvement.

Until within the last hundred years, the rags were prepared by washing them, and then allowing them to rot, so as to allow of speedy separation of the fibre from the gluten or fatty matter. The fibre was left almost whole, hence it retained great strength. The beating engine, by which rags are now torn into shreds in a short space of time, was an invention of the Dutch, and it was long known by the name of "the hollander." Instead of pounding the decaying rags in a morter, occupying twenty-four hours to pulp 3 lbs. or the five thousandth part of the pulp needed by a modern paper-making machine, the beating engine does all that is required, while by the aid of caustic soda, bleaching powder, and the process of boiling, the filthiest rag or esparto is purified to the whiteness of snow-flakes.

Foremost among pioneers in paper-making have been Messrs. Alexander Cowan and Sons of Edinburgh. The trade never owned a more shrewd and intelligent member than the founder of this firm, who commenced life in 1780 as the owner of a small mill at Greenlaw near Penicuik. Used alternately as a paper mill, then as a gaol for our French prisoners, and re-sold by the Government for a "a song" to the Cowans, the place has undergone various changes since, until now it cannot be rivalled by any in the United Kingdom, unless it be by that of another great house, Messrs. Alexander Pirie and Sons, whose works at Stoneywood near Aberdeen, are a marvel to all who visit them. But the Esk boasts some of the best mills in the country, including those of Annandale, Sommerville, Tod, and others, all of them holding the highest position in the trade. In similar manner, Kent produces more fine paper than any other county in England. In this connection we would mention the names of Joynson, Monckton, Towgood, Allnutt, Balston (Whatman's Hand-mades), Busbridge (Patent "Vat" Papers), Hollingworth (Turkey Mill), Nash,

Saunders, (Hand-mades), Spalding & Hodge, Turner and others.

Another of the pioneers of modern paper-making in England was the late Mr. John Dickinson. This gentleman was more than practical at the business: with him it was a science, and many were the improvements he patented in connection with it. *During a long life time (1782 to 1869), he was, with characteristic* energy, adding to his business, until it comprised, not only paper making, but card and envelope manufacture, as well as a variety of other minor branches. All the while, he so maintained the high character of the firm as to cause it to command the respect of the trade all over the world.

Before referring in detail to the various classes of paper, it will be well to notice the earlier attempts at paper-making machinery.

The first essay was made by Louis Robert who in 1799 took out a patent for producing endless paper. Although the French Government encouraged the enterprise, and awarded Robert a prize of 8,000 francs, the troubles in which the country was plunged at the time, caused the inventor to take his model to England, where it was adopted by the Messrs. Fourdrinier, who spent £60,000 in the endeadvour to perfect it, but without success or encouragement from either Government or paper-makers. Their engineer, Mr. Donkin, whose firm still exists, laboured hard to ensure the fame and pecuniary gain which the Messrs. Fourdrinier so well deserved, but these efforts only met with that disappointment which seems to have been the fate of most inventors. It is a remarkable fact that this machine, after being discarded for a number of years and several substitutes tried meantime with more or less success, was once more resuscitated; and it is this very machine, greatly perfected, of course, which is now employed everywhere for the manufacture of web paper. One of the substitutes tried, and which was used for some time in France and Ireland, as well as in Scotland, was the one patented by Mr. Robt. Cameron of Springfield near Edinburgh—a mill favorably known for manufacturing first-class printings and engine-sized writings. Cameron's machine did not, however, make in the web, but in sheets. This was its weak point, and caused it to be entirely superseded later on by Fourdrinier's invention.

While noticing the pioneers of the web machine, it is only fair to refer to the great improvements effected in the preparatory stages by our American cousins, more especially in machinery for pulping and cleaning the raw material. The Beating Engines by Kings, by Jordan, and by Gould, are all transatlantic, as also the Strainer, the Patent Apron, and other recent improvements.

There are now so many descriptions of paper made that it would be folly to attempt even to name them all, and to the uninitiated it would be unmeaning and useless. There are (1) Printings, embracing both white and colored, from the commonest "News" up to the finest "Book" qualities; (2) Account Book

Papers, comprising the ordinary kinds made on the machine ; (3) Account Book Papers, made by hand ; (4) Handmade Loan and Bank Papers, which are thin and remarkably strong ; (5) Writings, both machine and tub sized, esparto and rag ; (6) Browns, Packings, &c. These are the headings under which all makes may be classed.

All Papers except Handmades are manufactured on the web machine. The *modus operandi*, to put it into a few words, is as follows:—The esparto (or rag) having been thoroughly cleaned, is boiled in soda liquor, then torn to shreds and reduced to pulp by the beating engines ; the pulp is thereafter washed very thoroughly, so as to remove all traces of chlorine, and is finally run off into the vats which feed the paper machines. By these the pulp is rapidly converted into a web of paper—first passing through a strainer on to a sheet of wire cloth, through which the water percolates, leaving the fibre in an endless sheet. The wire cloth referred to has a lateral shaking movement, thus ensuring regularity of the deposit, while the water passes away. A few seconds only is needed to convert the milk-like pulp into moist, but perfectly formed, paper. The drying process then begins, the second half of the machine consisting of a series of drying cylinders, the finished web finally winding itself round a beam at the other end. The width of the paper is determined and regulated by what are called " deckle straps " at the sides, which move along with the wire cloth bed. These machines are made of various widths up to 80 inches. Water-marks in paper, as well as " Wove" and " Laid" textures are formed by means of " Dandy Rolls," on which are sewn with copperwire words or devices that are to be impressed in the paper.

" *Engine-sized*" Papers are treated rather differently, the web being passed through a trough of gelatine after it leaves the drying cylinders, and from whence it is carried over a series of skeleton drums to be " air-dried." So thoroughly do some paper-makers attend to this, that special machines are made for the purpose. The first of these (which the writer has had the pleasure of seeing) was set up at Valleyfield Mills, near Penicuik by Messrs Alexander Cowan & Sons, and is fitted with no fewer than 384 ventilating drying cylinders, arranged in three lines one above the other, the paper travelling over all these until it reaches the cutter, where it is cut to size. The whole of these cylinders can be stopped in a few seconds, when any one of the tapes or other parts give way. The enormous expense of such a machine has prevented its general introduction, only one other mill (in the United States) having as yet emulated the enterprise of the Messrs. Cowan. The time occupied in making, drying, sizing, calendering, and cutting, is rather less than an hour and a quarter.

Fine writing papers are differently treated. After being cut into sheets, these are " tube sized," and most carefully dried, then passed through calender rollers, the sheets being separated by

polished copper plates, so as to give it a high finish.

Hand-made papers are produced by the same process as that by which all papers were made a hundred years ago. The pulp is run into wire moulds held in the workman's hands. These sheets are laid one by one on felt, so as to draw off the water, squeezed in a press, and hung up to dry, before being tub-sized and glazed.

We shall merely enumerate the various substances out of which paper is now made—viz., rags, esparto, straw, wood, jute hemp, leaves, rough grass, and old ropes.

We have already seen that the first paper was made from cotton, but doubtless it was soon discovered that rags were equally serviceable with new fibre. There is nothing, now, that is too mean or useless to be unsuited to the requirements of the paper mill. All materials, linen, cotton, silk, wool, are equally welcome the first three serving for the finer writing papers, the last an admirable ingredient in Blottings. Some mills can work rags only, others esparto only, others both. The best writings (Hand and Machine made), Drawing and Plate Papers, also some mixed Printings and Blottings, are made from rags ; and there can be no question that "rags are yet king." It must be evident, however, that the supply of this material is much too small to answer for a tithe of the paper made. Of all the flax and hemp taken from the soil, only one-fortieth reaches the stage of pure white linen, the rest becoming waste during the process ; and when this, worn out, reaches the paper mill, another large proportion of it is lost ere it becomes paper. The consumption of paper having multiplied over and over during the last two decades, the substitution of other materials became absolutely necessary ; and one of the first of these was esparto. It was not till 1860 that this fibre came into general use, and, then, the supply seemed ample for many years to come, but the enormous increase in consumption led to forced cutting of crops, and production has fallen off from 2 to 10 per cent. By the year 1871 the take-off was 140,000 tons annually. As esparto seed does nor yield fibre for twelve or fifteen years, it will be seen that the extermination of the plant is certain though slow, unless its culture is most carefully attended to. It contains a larger percentage of fibre than ordinary straw, and therefore yields more paper, but it loses no less than 44 per cent. in the course of manufacture. It is from esparto that nearly all of our better Printings are made, and a large proportion of our writings too. Straw produces a rather harder paper than esparto, more brittle, and with more impurities. The use of Wood for paper goes back as far as the middle of last century, and a book then published by Dr. Jacob Christian Schaeffer contains upwards of sixty specimens of paper made from various substances—among these being wood. It was not, however, until about thirty years ago, that the Americans commenced the manufacture on improved principles, and now they produce wood-paper of highest quality

and at extremely moderate cost. England and the Continent respectively have entered the lists, and some of the paper they manufacture is a good imitation of hand-made. The great objection to it is, that it is extremely perishable, its woody nature being apparent, when it dries from age, in its crumbling, powdery appearance.

Another and more successful fibre is cane. This manufacture is almost entirely confined to the Southern States of the American Union, where a number of companies carry on a very large and profitable trade, protected by patents taken out twenty-five years ago. The cane, which grows in the swampy grounds of the Carolinas and Virginia, is disintegrated, through being saturated with steam while confined in a monster "cannon," the muzzle of which being opened, fires the cane against a target on which the mass strikes and is reduced to a fibre. It yields a strong and yet soft paper, and as the supply is, thus far, nearly inexhaustible, it is is probable that the Americans will improve still further the quality of their present outturn.

Another fibre is Jute, of which America consumed in 1883 no less then 73,785 tons, the greater part of which (in the shape of Butts and Rejections—65,598 tons) was turned into paper.

Previous to 1867, old Gunny Bags had been used for jute paper, but about that time, a well-known Calcutta house collected all the useless fibre and sent it to America as paper stock, until now it constitutes the chief component of a very large proportion of so-called " Manilla " paper, as well as the bagging, browns, &c., used in the States. Jute Paper, being made from a very strong virgin fibre, is remarkably tough, and, save for its color, would have come into more general use.

In addition to the foregoing substances, there are a variety of papers made for special purposes, as for, instance—Paper for Collars; Cigarette Paper, made sometimes from manilla grass, but now largely from maize ; Tissue Papers, made from hemp and cotton ; Bank Note Paper, made from the best white linen rags, as also from Scotch and Irish flax, and bleached without the aid of vitriol; Paper for Roofing and Building, made from straw, waste paper, and the commonest kinds of rags ; Parchment Paper, used largely by chemists, made from unsized rag, dipped in sulphuric acid, washed in water and ammonia, and then passed over dryers, rendering it hard and parchment-like ; and last of all, Mill-boards, manufactured from oakum, bagging or rope, tarred or dry ; Straw Boards, from straw ; Leather Boards, from leather refuse and clippings ; Printer's Pressing Boards, from manilla grass or jute. These are all forms of paper, and all made in much the same fashion as paper, but requiring more or less care according to the fineness of the stuff to be made.

It may be worth mentioning here that there are various kinds of paper made from Indian fibres by the Natives of this country ; they are hand-polished with shells, until they assume a high glaze ;

papers made in Bhootan, Nepaul, and Thibet, unglazed, but of extraordinary toughness ; the common packing paper made in several of the Jails ; as also Botanical Drying Paper. All these are full of impurities, and very irregular in texture. Their recommendations are that they are cheap aud strong.

The Chinese have, as already stated, made paper from a very early period in their national history. It is different from all other kinds, made being of rice and silk pulp, remarkably soft, glossy, and strong. It suits admirably their peculiar system of printing, *i.e.* from blocks ; and so wedded are these strange people to their ancient ways, that, thus far, they have adhered to their own paper, spite of Western production being offered to them on both cheap and easy terms.

We will now give a few statistics of the Paper Trade.

It is stated that there are 3,935 paper mills in the world, producing yearly 959,000 tons of paper. About one-half of the quantity is printed upon ; and of these 476,000 tons, about 300,000 tons are used by newspapers. The various governments consume in official business about 100,000 tons ; schools, 90,000 tons ; commerce, 120,000 tons ; industry, 90,000 tons ; and private correspondence 90,000 tons. The paper trade employs 250,000 hands, *including women and children.*

The United States own no fewer than 669 mills, which produce over forty-eight million dollars worth of paper per annum. Of these. 179 (or more than one-fourth) are to be found in New York State alone.

In the United Kingdom there are 385 mills, working 526 machines. These produce 350,000 tons besides 10,000 tons of Hand-made, in all, say 360,000 tons, valued at £16,000,000. Of this production *Great Britain* exports 16,000 tons, but she imports 24,000 tons, so that she consumes 6,000 tons, more than she produces.

A German savant informs us that the various nationalities, cnnsume paper as follows :—the Russian 1 ℔ per head, the Spaniard 1½ lbs., Mexican 2 lbs., the Italian and Austrian 5 lbs. the Frenchman 7 lbs., the German 8 lbs., the American 10¾ lbs. the Englishman 11¼ lbs.

The total Capital engaged in the Paper Trade is nearly fifty million pounds, of which three-fourths represent plant, and one-fourth working capital.

It is remarkable that America manufactures all her paper on the machine, and does not own one mill for Hand-mades. Their very best qualities are thus made. Their best, however, bears no comparison with paper like Whatman's Saunders,' Hodkinson's, and others, and they annually import large quantities of these makes, *while the various attempts they have made to* oust English hand-mades have met with complete failure.

India consumes a very large quantity, the imports into Calcutta for 1883, being—Printing Paper 3,200 tons, and Writing

Paper worth 3¼ lakhs of Rupees. Of this the larger proportion was English-made, a considerable quantity, however, being from the Continent, Germany and Belgium in particular.

Our local mills at Bally and Titaghur, were not the pioneers in this branch of civilization. A mill existed for many years at Serampore (hence the common name of " Serampore Paper "), and we well recollect seeing the silent and rusty machinery as far back as 1864. The Local Mills manufacture Brown, Half Bleach or " Badami," White and Colored Printings, Blottings, &c. On these the mills find work enough and to spare, large orders being given by Government alone. In the first of these (Browns) they have driven Europe-made papers entirely out of the market ; their Coloreds and Blottings meet with a limited demand ; while their Printings are used freely, and are of fair quality.

D. M. TRAILL.

THE FORMATION AND PROPERTIES OF HUMUS.

The black organic matter of soils called humus is due to the decay chiefly of vegetable matter. This decay is brought about by the attacks of moulds and bacteria, the former alone causing the production of dark-coloured matters. P. A. KOSTYTCHEFF has recently been investgating this subject, and has been experimenting with various kinds of vegetable *débris, e. g.*, grass, Oak, Elm, and other leaves. He found that as these matters decayed, there was invariably no loss of nitrogen. Now grass and leaves contain proterus, and these decompose into ammonia, a gas which partly consists of nitrogen, and since there is no loss of nitrogen, *it follows that the ammonia must be reconverted into other substances*, and this appears to be done by the agency of living organisms, which find their nourishment in the decaying matter. Ammonia and similar substances serve as nutriment to moulds, in the protoplasm of which their nitrogen is stored up, and this decomposing in its turn serves as food to bacteria, which still retain the nitrogen in proteid combinations. The soil, with its estimated 60,000,000 of organisms per gramme, must contain much nitrogen in the proteid form, and one set or other of organisms will predominate according to variation in the conditions. In general, the first development in decaying vegetable matter is that of bacteria, the medium becoming acid; then follow the decay of these bacteria, the ammonia produced neutralising the acid, *and moulds growing in the neutral medium; afterwards* bacteria and moulds develop together. Thus, humus always contains easily decomposable matter, and consequently, the rate of decomposition observed at any period of the decay is about the same. In humus produced above the water-line, all trace

of vegetable structure is destroyed by the leaves being gnawed and passed through the bodies of earthworms, caterpillars, wire-worms &c., under the waterline, the vegetable structure is preserved, and peat results. Experiments with dead leaves pulverised by the action of these animals, in comparison with the same leaves not attacked by them, show that little or no influence on the on the rate of decay results from their action. After passing through their bodies, the organic matter is still fit to nourish moulds and bacteria, and when these have multiplied sufficiently to accumulate a fresh stock of protoplasm, the earthworms, &c., attack it again, and so destroy all trace of structure. The soil of black lands is permeable to a small depth only by water, and this circumstance retards decomposition, and accounts for the accumulation of humus. The decay of humus is fastest in the best drained and most open soils ; for this reason, the presence of clay in a soil promotes the accumulation of humus. Woods promote drainage by loosening the soil and abstracting water, and hence in plantations the accumulation of humus is retarded, and the earth becomes lighter in colour. Inferior organisms are a means of diffusing organic matter throughout the soil—the mycelia of fungi, for instance, growing on a dead root, ramify laterally, and thus carry organic matter a little outward ; succeeding organisms extend this action, and the soil becomes darkened in proportion. The humic acid of black soil is almost exclusively in combination with lime ; this lime is, according to KOSTYTCHEFF, carried to the insoluble humus as acid carbonate dissolved in the water, and the acid carbonate is decomposed by contact with the moist humus. KOSTYTCHEFF is a member of the Society of Naturalists of St. Petersburgh, and his paper, which is a long one, has been reproduced in several of our German contemporaries.

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FORESTRY IN NORTH AMERICA.

PART I.

The following is a somewhat abbreviated translation of a paper on the North American Forests, which has been lately read by Sir Dietrich Brandis before the Natural History Society of Bonn. As the sources of his information, the writer refers to a number of recent publications on North American Forestry, the chief of which are "*A report on the Forests of North America*" by C. S. Sargent, Professor of Arboriculture in Harvard College, 1884, and Dr. Mayr's "*die Waldungen von Nord Amerika*" *Munich, 1890.* The first part of Sir D. Brandis' paper is occupied by some criticisms on Dr. Mayr's generalizations from his observations in America; and few men have such wide experience in observing forest vegetation as the former head of the Indian Forest Department and would be sooner able to detect a generalization from incomplete data.

Dr. Mayr is the son of a State Forest Officer in Bavaria and after studying Forestry and Botany very thoroughly at Munich, he was in 1885 sent to North America by the Government of Bavaria, to observe, at different ages, in their native forests, certain important trees, experimental plantings of which have been from time to time made in Germany. After spending seven months on these researches and afterwards extending his tour through Japan, Java, Ceylon, and northern Hindustan, Dr Mayr returned to Germany in 1888, and was shortly afterwards appointed Professor of Forestry and Forest Botany at the College of Agriculture and Forestry at Tokio in Japan.

This gave Dr. Mayr a second opportunity of visiting North America, and during these two visits, he twice traversed the country from East to West, and also journeyed from Canada to Florida, and from Vancouver's Island as far as Mexico.

Besides Dr. Mayr's actual observations during his stay in North America, he has made use of the rich material found in Professor Sargent's work already referred to, and also of the Annual Reports of the United States Agricultural Department published since

Der Wald in den Vereinigten Staaten von Nord Amerika, von Dr. D. Brandis, in Bonn, 1891. Sonder Abdruck aus den Verhandlungen des Naturhistorischen Vereins; 47 Jahrgang.

1877 in Washington, which give much information regarding the North American Forests.

The Forest Bureau of the Ministry of Agriculture was founded in 1876, and Dr. Franklin Hough was the first chief. He was succeeded in 1886 by Berhard Fernow, a Prussian trained forester, who is still at the head of the United States Bureau of Forestry. Fernow, in 1889, published in French a short account (43 pages) of the Forests of North America, to accompany the Forest collections intended for the Paris Exhibition of 1889.

Dr. Mayr treats of the demands of the more important North American trees as regards climate and soil, with a summary account of their anatomical structure and of the physical and technical qualities of the most important woods. He also gives lists of destructive fungi and insects which he observed on different species. The book has made a considerable stir in the United States, and some criticisms regarding the account of some of the fungi described by Dr. Mayr have already appeared in *Garden and Forest, 1890, p. 627.*

We now come to the generalizations which Sir Dietrich Brandis has controverted.

In Mayr's introductory chapter, entitled—General notes on the conditions of existence of Forests—we find the unsound statement that evergreen broad leaved forest (not coniferous) requires a higher winter temperature than deciduous forest; and, again, deciduous vegetation is always absent in tropical countries on account of the uniformity of the climate throughout the year.

If Dr. Mayr had visited the forests in the very hot, damp countries of Burmah and India, he would have noted that deciduous broad leaved forests form the most important forest area of these countries. The teak and a number of allied trees lose their leaves from December to February, and the new foliage only appears in May or sometimes in April. Extensive tracts of deciduous forests without teak are also found in these countries. The evergreen broad leaved forest is only found in the dampest parts, on the ridges and slopes of the mountains exposed to winds from the sea, in damp valleys, or in deep and very moist soil.

This distinction between deciduous and evergreen forest is of the greatest importance in Indian Forestry, as forest fires rage through the deciduous forests at the hottest period of the year whilst they only damage the fringes of the evergreen forests. The trees in the deciduous forests are leafless, but not on account of the cold, for although the temperature is lowest in January, yet March and April are frequently the hottest months in the region referred to. It is on account of the dry season that they are leafless; these facts are also given by Junghuhn in a work frequently quoted by Dr. Mayr about Java, where it is the teak forests in the eastern part of the island that lose their leaves annually in the driest months beginning with July, but become green again in March and April at the end of the rainy season. In India, it is the

degree of humidity and not the temperature which causes the broad leaved forest. In many valleys of the Yomah mountains in Pegu, the northern slopes are covered with evergreen forest, whilst the southern slopes bear the far more valuable deciduous forest, containing teak. In the same way the Ghât mountains on the Western coast of India, contain vast areas of valuable deciduous forests with teak at the foot and lower parts of the chain, where, in the absence of any shade, the heat is intense from January to May. In damp valleys, we may find the evergreen forest low down the hills, surrounded by deciduous forests, which extend higher up on the dry slopes and ridges and with the mass of evergreen forest in the cooler and damper atmosphere of the higher slopes up to the crest of the mountain chain.

Coming over the ridge into a drier region, the deciduous forest re-appears, similar phenomena being found in India beyond the Ganges. It is hence clear that Dr. Mayr's statement on page 10 of his book, that deciduous forest is always wanting in tropical countries, is not at all true. Sir D. Brandis maintains that similar phenomena are found in other parts of the world besides Asia and cites cases in Brazil, Venezuela and tropical Africa, for which see *Botanische Zeitung, 1876, p. 38.*

These deciduous tropical forests are termed by Drude in his new manual of Geographic Botany, p. 254, as *tropische regengrüne Wälder*, tropical monsoon green Forests. America is much richer than Europe in forest trees, for, compared with our 52 genera and 158 species, Sergent's Catalogue for 1883 of forest trees of North America, exclusive of Mexico, includes 158 genera and 412 species of forest trees, only a few of which are, however, of commercial importance. According to Fernow these are about 30 to 40, of which only 10 or 12 are brought to the market to any great extent. Several new species have been discovered since 1883, and a good part of the northern forest tract near the Pacific is not yet thoroughly explored.

Sergent's 412 species, including all species in British North America, given by him in another list, may be classified according to their Geographical distribution, as follows:—

Atlantic tract	176
Pacific "	106
Species common to both	10
Species of the middle tract of the Rocky Mountains and border regions	46
Tropical species near the coast of Florida	74
	412

The trees common to the Atlantic and Pacific tracts are as follows:—

Betula papyrifera.
Populus tremuloides.
Do. balsamifera.

Picea alba
Pyrus jambusifolia (resembling our Mountain Ash.)
Salix nigra.
Do. longifolia
Do. amygdaloides.

Juniperus virginiana, extending from New Brunswick to Florida and in British Columbia, Colorado, Nevada, &c.

If we omit the 74 tropical species, we get 338 species in the United States, against 158 in Europe.

Sir D. Brandis considers numerical comparisons as misleading, as different authors do not recognize the same trees as independent species and it is hard to distinguish always between shrubs and trees. It is moreover clear that we may consider North America as richer than Europe in Forest species. Brandis here states that a number of American forest genera existed in Europe in tertiary times, but have since disappeared.

At present the following are known *Gymnocladus Kamamehi, Liquidamber, Planera, Carya, Chamæcyparis, Taxodium Sequoia and Pinus,* section *Tæda.* The only genera of European trees not found in North America are *Ceratonia, Laburnum, Olea, Syringa, Laurus,* whilst many species common to both countries are now only found in Europe south of the Alps.

One might therefore suppose that north of the Alps they were extirpated during the glacial period, being still able to maintain themselves to the south of the Alps. These species at present are distinguished under different appellations, but Brandis considers the characters of difference not sufficient to separate them, as has been recently demonstrated by Fliche in the case of *Ostrya virginica* (1).

The following are suggested as instances and it is noteworthy that all six are found throughout the Atlantic region from north to south.

1. *Cercis Canadensis L.=Siliquastrum* L. of the Mediterranean region.
2. *Diospyros virginiana L.=Lotus* L., perhaps introduced into the Mediterranean region, but indigenous in West Asia to N. W. India.
3. *Celtis Occidentalis* L=*australis* L. Mediterranean region and West Asia.
4. *Platanus Occidentalis* L=*Oriontalis* L. Eastern Mediterranean region.
5. *Ostrya virginica* Willd=*carpinifolia* Scop. Mediterranean region.
6. *Castanea Americana Mich=vulgaris* Lam. Mediterranean region, Central Asia.

Betula Populifera and B. papyrifera also greatly resemble *B. alba and pubescens* of Europe.

(1) NOTE.—Sur les formes du genera *Ostrya*, Bulletin de la *Société botanique* de France, T. XXXIV p. 162.

Engler's "Evolution of the Vegetable Kingdom" gives much that is of interest in the evolution of the extra tropical Hemisphere, but many doubtful points must be cleared up before we can understand the connection between European and North American Forest flora. Dr. Mayr divides the forest flora of America into 4 *heads*—

A. Atlantic region forest flora.
B. Prairie " "
C. North " "
D. Pacific " "

A extends from the Atlantic Ocean up to 95 degrees West longitude, and includes a small tract of tropical forest at the northern extremity of Florida, rich in many species common to the West Indies, but of little importance in forestry. This flora is really tropical as Mayr states, being carried to 25 degrees north latitude owing to the heat of the Gulf stream. Sergent terms it semi-tropical, similar outlying tropical vegetation is cited by Mayr in the Riukiu Islands in Japan, and by Brandis at the foot of the Eastern Himalaya in lat. 28 degrees with a very damp climate and protected against winds from the north.

Bordering on this small region of tropical forest, extends along the coast of the Gulf of Mexico and the Atlantic Ocean up to lat. 36 degrees a wide strip of evergreen broad leaved forest, in which the dark green shining leaves of *Magnolia grandiflora*, several oaks, and the paler green of the north American laurel, *Persea carolina*, are striking features. Mayr describes the bright green arrow-like leaves, several yards long, of *Tillandia usneides*, whilst the space between the crowns of the trees and the soil is crowded with evergreen shrubs of all sizes.

On raised sandy hills the pine forest of Florida and the adjacent states extends northward into Georgia, South and North Carolina to lat. 36 degrees and west to Alabama and Mississippi. The Southern Maritime Pine Belt (Sergent) extends far to the west of the Mississippi river. *Pinus australis* also named *p. alustrios* is the most valuable of the several species here occurring on account of its splendid timber, and yield of turpentine. The reddish heart wood of this pine is used for furniture and cabinet-making throughout north America and exported in large quantities to Europe under the name of Pitch Pine.

Quite another species, however, *Pinus rigida*, which is abundant in the northern Atlantic States, bears the name of Pitch Pine in America and is there almost exclusively used for fuel. The zeal for planting out this inferior species in Germany is probably due to a mistake in nomenclature. *Pinus australis* is a comparatively slow grower, whilst the Loblolly Pine, *Pinus Tœda* and *Pinus cubensis* are of quicker growth and if the present absence of forest management continues, they will endanger *Pinus australis* which, owing to its fine durable timber, is in great demand. According to Fernow, the mean annual local

value of the production of turpentine from these southern forests amounts to 8 million dollars or £1,675,000. The extraction of the turpentine is of the roughest nature, much material is wasted, and more wood is annually destroyed by resinage and fire, than is utilized as timber. Large areas of the forest are annually destroyed by fire. A fourth species which is coming in from the north and replacing *P. australis,* where the latter has been extirpated, is *P. mitis* with two and rarely three needles and, according to Mayr, agreeing anatomically with the three-needled pines and with which it has also the common property of reproducing itself up to a diameter of a decimetre from dormant buds, close to the point of section.

In the southern, warmer parts of this Pine tract, a small palm *Sabal serrulata* with fanshaped leaves, and stems creeping along the soil, forms a useful soil shelter in the Pine woods thinned by fire and pillage. This will not, however, in Mayr's opinion, hinder the eventual destruction of these valuable forests, and no one will believe, 50 years hence, that the broad sandy deserts of the Gulf States, whiter than snow with sand driven about by every wind, once contained magnificent trunks of the best pine in the whole world. From observation of the different species of American southern pines, Mayr lays down as a general law that in the south grows the heaviest pine wood most rich in turpentine, whilst as we proceed northwards these characters get poorer until the most northern of all pines, *P. strobus,* yields the lightest wood, and is not particularly rich in turpentine. He also states that the length of the needles decreases towards the north as warmth and humidity decrease.

These assertions are only made by him for species of the Atlantic region of North America. As a comparison Brandis gives the following table for the Pines of India :—

Rainfall.	Section.	Name.	Distribution.	Altitude.	Length of needles in Inches.	Weight in lbs. in cubic feet.
Moderate ..	Cembra ..	P. excelsa Wall.	Bhutan—Kafiristan lat. 27°—35°. ..	5,000—12,500	6″—8″	30
Dry, but good monsoon..	Tœda ..	P. Gerardiana Wall ..	Garhwal to Kafiristan lat. 31°—36° ..	5,800—10,000..	3″—5″	46
60 inches ..	Do. ..	P. longifolia ..	Bhutan—Kafiristan lat. 27°—35° ..	1,500—7,000 ..	9″—12″	41
70 inches ..	Do. ..	P. Khasya ..	Burma, Assam lat. 18°—27° ..	1,800—6,000 ..	4″—8″	38
160 inches ..	Pinaster..	P. Merkusii ..	Borneo and Sumatra to Burma and Siam lat. 0—17°	Sumatra 3,000 to 4,000 Burmah 1,000 ..	7″=9″	15

It is remarkable that *P. Merkusii* has the heaviest wood and except for *P. longifolia*, the longest needles.

Pinus excelsa and *Gerardiana* are pretty nearly alike in heat requirements. *P. excelsa* grows naturally from above 8,000 feet to the highest tree limit, where it forms large forests and attains a great size. As the species can exist under different climatic conditions and is an invasive species, it has extended far beyond its original home. The trees bear seed young, and in large quantities, and they have large wings and thus are blown to considerable distances, whilst the young plant is very robust and can do entirely without shelter, so that it has spread over grassy slopes, wherever there are not too many sheep and goats, and *where the grass is protected from the annual fires*, and has covered vast areas with secondary forest.

It is remarkable that this tree (also found between 3,000 and 6,000 feet in Macedonia) succeeds admirably throughout Western Europe, whilst *P. Gerardiana*, which flourishes in the driest and most remote parts of the Himalaya in a climate most resembling that of Europe, requires shelter in Germany.

Pinus excelsa has longer needles than *P. Gerardiana*, but a much lighter wood, whilst neither species requires a large degree of heat. In Europe, the northern *Pinus sylreotris* and the southern *Pinus halepensis*, resemble one another in length of needles and in specific weight of wood. Any connection between climate, length of needles and specific weight of wood can hardly be established in any country. *Pinus longifolia* has longer needles and its wood a greater specific gravity than the sub-tropical pine *Pinus Khasya*, though it is indigenous in a more temperate climate than the latter. The tropical Pine *Pinus Merkusii* has, indeed, a heavier wood, but much shorter needles than *P. longifolia*.

The tropical Pine *P. Merkusii* grows in the valleys of the great rivers of India beyond the Ganges, where the mean temperature of the warmest month is 84 degrees Fah. and of the coolest 75 degrees, the absolute max. and min. in the shade being 100 degrees and 59 degrees. The monsoon lasts six months from May till October, with a mean annual rainfall of of 500c. only 3 per cent of which falls in the six dry months. Here, in lat. 17 degrees N. in the Thoungyin Valley of the Burmese province of Tenasserim at a height of 180 m. above sea level, *P. Merkussii* forms extensive woods containing *Dipterocarpus tuberculatus*, and other trees of the tropical forest.

In his general chapter about the conditions for the existence of forests, on page 7, Mayr says that no pine forests occur in tropical vegetation and if pines extend to the tropics, they are only found by reason of their altitude, in sub-tropical regions.

This statement does not agree with the above description of the two-needled pine *P. Merkussii* in the tropical forests of Burmah and Siam.

In connection with his description of the forests of the South Atlantic States, Mayr, p. 104, maintains that oranges and grapes and in general all fruits are better flavoured and richer in aroma, the drier and warmer the climate may be; naturally up to a certain degree. In Japan, Ceylon, Honolulu and Java, oranges and grapes grow as well as in Florida, but as regards flavour they, according to Mayr's taste, are much inferior to those growing in the dry warm continental climate of the Mediterranean coasts, Afghanistan, China and California. It is quite true that oranges have not the same excellent flavour in every country in which they thrive. In Hindustan and northern India, oranges are produced nearly everywhere, but only in a few places are they so excellent as to become a considerable article of trade. One place is Delhi, with a dry, hot climate, a four month's temperate season from November till February, with 59 degrees and 93 degrees Fah. as the mean temperature of the coolest and hottest months, January and June, a nine month's long dry season in which the mean relative humidity is under 50 per cent and sinks to 33 per cent in April, and a mean annual rainfall of 27 inches, the mean relative humidity of the three rainy months being 65-68 per cent. A second place is Nagpur, the centre of Hindustan, always hot. December is the coldest month with a mean temperature of 67 degrees. May is the hottest month with 93 degrees, eight months dry season from October till May, the mean relative humidity from March till May 28-32 per cent and only in the four rainy months considerable, 60-80 per cent. At this season there are heavy rains, with a mean annual rainfall of about 44 inches. These are the two examples of places with a very hot, dry climate, which produce excellent oranges.

As fine, if not finer, are however the the oranges produced in the extensive orchards at the foot of the Khasia mountains, under the well-known station Cherrapunji, which has the highest annual recorded mean rainfall in the world, about 500 inches. Cherrapunji 4,452 feet above sea leavel. Shalla, where the oranges grow, is at an altitude of about 980 feet with an annual rainfall of about 200 inches. The dry season here is short, from November to February and the rainy season lasts 8 months. The trees are neither grafted nor manured, and yet the oranges are finer than those which are cultivated with the greatest care in the gardens of the Riviera and Provence. They ripen in December and January, and the value of the oranges sold every year in Calcutta (distance 450 km.) is from £15,000 to £20,000. Another country with a very damp climate which produces excellent oranges and supplies Rangoon, exists on the Karen mountains eastwards of the Sitanj river with a mean annual rainfall of about 400 c.

Thus in East India, oranges attain perfection in very hot and dry and also in very moist climates, so that Mayr's dictum will not hold good, at any rate for this country, that the best oranges are only produced in a dry, hot climate.

To return to the southern Atlantic forest flora, Mayr gives a clear description of the deciduous swamp Cypress, *(Taxodium distichum)*, the giant cedar of the East, as it is called. In the southern Atlantic States, this remarkable tree forms pure woods of large extent in lowlands which are inundated several times in the year, the flat, umbrella-shaped crown, 130 feet above the ground, in November reddish brown with the autumn tint of the foliage, with the bright green *Tillandsia usneoiides* hanging from the stems. The base of the *Taxodium*, as of other trees which grow in these swamps, *Liquidambar*, *Nyssa*, *Fraxinus*, bulges out like a bottle. From the roots of the *Taxodium* a number of hard, pointed, outgrowths project, called the knees of the swamp cypress, which apparently have the function of assisting the aeration of the roots. The bottle-shaped swelling of the lower part of the trunk has also possibly a similar purpose. From the swollen base a clean straight bole rises to a considerable height.

In the southern Atlantic States, also flourishes at its best, the red cedar, *Juniperus virginiana*, the light, sweet-scented and very durable wood of which forms the framework of our pencils. The Sawmills which saw up the wood for European consumption in Pencil manufactories, are chiefly in northern Florida and in eastern Texas, where the tree attains a height of nearly 100 feet. Rightly does Mayr insist on the important circumstance, already known though Professor Sergent's works, and earlier still, that this Juniper grows under very varying climatic conditions, extending from hot, winterless Florida to the cold coast districts of New Brunswick, and from the damp Atlantic coast to 100 degrees W. longitude, in the prairies and in the western half of the continent, from the Rocky Mountains in Colorado to British Columbia. However, as one might expect, in the northern parts of its range, as well as in the dry climate of the prairies, it grows hardly larger than does the common European Juniper.

The greatest in extent of all the classes of forest in the Atlantic States is the deciduous broad-leaved forest of the temperate region. This extends up to the great northern lakes, but on the sandy deposits near these lakes, as well as near the sea coast, it is replaced by extensive Pine Forests. Pines are also found on sandy soils in the mountains. Mayr distinguishes two great sub-divisions of the broad-leaved forests: a southern half, extending to north latitude 39 degrees; and a northern half above that; and in each sub-division he further distinguishes an eastern, central and western or prairie tract. In the middle part of the southern tract the deciduous forest is best represented in the country west and south from the Alleghany mountains, in which the warm damp south wind penetrates a broad arm of the Mississippi Valley. A number of Oaks, species of *Carya*, two Walnuts, the Chestnuts, or, acccording to a phrase introduced by Mayr, the heavy seeded trees, are better represented in the south, whilst the cooler north is the home of light seeded species, chiefly Maples,

Birches and Elms. Everywhere this deciduous forest is distinguished by a great variety of species. In its best parts the better species grow vigorously and attain incredible dimensions. The Hickories, several species of *Carya*, are from 100-130 feet high, with diameters exceeding 39 inches and with clean boles like pillars. The black Walnut, *Juglans nigra*, attains, according to Sergent, a height of 146 feet; and the Scarlet Oak, *Quercus coccinea*, 177 feet.

The Tulip tree, *Liriodendron tulipiferum*, named the yellow Poplar, and much planted out in parks and pleasure grounds in Europe, attains a height of 197 feet with a diameter of 13 feet. It grows rapidly and its light soft wood is much prized.

(To be continued.)

REMARKABLE INSTANCE OF A FOREST FIRE CAUSED BY SPARKS.

On the 6th of July and just before the rains set in, whilst Deodar trees were being felled in the Kamari Block of the Deota forest, Jaunsar Division, School Circle, N. W. P., a rather unusual case of fire occurred, the particulars of which are stated to be as follows :—

In the first place it should be noted that the geological formation of that portion of the Deota forest consists of quartz and the place when the trees were being felled has a gradient of about 45 degrees.

On the felling of a tree, a large rock is said to have become detached which rolled down the steep slope, and at a place situated about 100 yards below, it appears to have struck another quartz rock. The rock seems to have been covered with dry grass and Deodar needles and immediately on the collision taking place, the felling men observed smoke rising from the place, and when they got down they found the grass on fire, but managed to extinguish it, but not till about 50 square feet had been burnt.

A few days afterwards the case was enquired into on the ground by the Forest Ranger in charge and subsequently by me, and the following conclusions have been arrived at. As there is no path near the place, and it being also highly improbable that any one would indulge in the heinous offence of smoking just below a place where trees were being felled on a slope of 45 degrees, it is most probable that the sparks caused by the falling rock striking the other led to the ignition of the grass and deodar leaves, and that therefore the statement of the felling men is probably correct.

An old contractor who has been employed for 25 years on these works also informs me that a similar case occurred some years ago whilst his men were employed in felling Chir trees on a steep slope near the Tons river, so that it is just possible that the falling of stones may probably account for some of the unexplained outbreaks of forest fires.

August 21st, 1891. E. McA. M.

FORESTRY IN KASHMIR.

We have received a "Report on the Forests of the Jammu and Kashmir State for ten years, commencing from Sambat 1937 to 1946 both years inclusive," compiled by Diwan Amar Nath, Chief Forest Officer. This being interpreted means from 1880 to 1889, A. D.

Diwan Amar Nath took over charge of the Forest and Timber Departments in October, 1890, and in six months produced the report under review, so he lost no time in his endeavours to throw light on the peculiar transactions of the timber dealers in Kashmir. He found disorder and confusion reigning supreme, records and papers scattered over several offices of the State, and nearly four hundred files pending disposal.

As regards their produce, the reserved forests of the State are divided into two classes. The first category includes all timber producing tracts, the principal trees being Deodar, *Pinus longifolia, P. excelsa, P. Gerardiana,* Shisham, Toon, Moru Oak and Box; the second class includes fruit bearing trees, medicinal herbs, '*tranger mall,*' which appears to be the fruit of sundry wild plants, pasture lands, and several kinds of inferior wood technically known as 'Banesari,' and mostly used as fuel.

Nothing whatever is known as to the area of the State Forests; and Diwan Amar Nath experienced much difficulty in ascertaining even the approximate length of the timber yielding tracts. He makes an attempt, however, and gives the names of the principal tributaries of the great rivers down which timber is floated. Thus the Jhelum river is credited with nine tributaries down most of which logs or scantlings can be successfully conveyed, the Chenab with five, the Jammu Tawi with six or seven, the Ravi with six, and the Ujh with seven.

A commencement of a survey has been made and an Overseer with nine subordinates has been deputed to prepare maps of some of the forests and of game preserves, "in order to fix their boundaries as correctly as possible in a cursory manner." But the Diwan clearly foresees that in order to secure good management of his forests, it will be necessary to appoint a trained Forest Settlement Officer with sufficient staff to carry out these duties and he also desires to obtain the services of at least two trained Rangers, and ten Foresters. He also makes the sensible proposal that three or four students should be sent every year to the Dehra Dún Forest School. We must congratulate the Kashmir Durbar on having obtained the services of an energetic Forest Officer from the Punjab as Conservator, and we feel sure that if he can succeed in cleansing the Augean stable, great strides will be made in Forest conservancy and administration. But it will be up hill work at first, and nothing but earnest support from a powerful durbar will enable him to carry out the necessary reforms.

The management of the timber department evidently leaves room for improvement as the following remarks show :—

" There is a bad custom prevailing in this department, according to which an imaginary measurement of timber at the time of 'its collection from a river is entered in the registers by the Mahal-'dar which is nearly 25 per cent. less than the actual quantity, 'consequently when the time for sales comes, a second measurement 'becomes a matter of necessity. This custom, which is a fruitful 'source of dispute and dishonest practices on the part of the offici-'als is alleged to have its existence in the fact that expenses of 'floating and salving timber are economized, but it cannot be too 'strongly deprecated for obvious reasons. It is therefore, import-'ant, to rule that as soon as timber is salved in a river, its correct 'measurement be at once entered in the register kept for the purpose, and that in future the salvage wages be paid after deducting '25 per cent. from the real measurement, or, which amounts to the 'same thing, wages be reduced proportionately instead of, as now, 'reducing the actual quantity of the timber salved and fully shown 'in their books.

'No attention is paid to classification of timber and arrang-'ing it according to its class or quality, it being kept in a promis-'cuous heap or scattered in a most irregular manner ; considerable 'difficulties are experienced at time of sales owing to this defect, 'and purchasers not unoften get opportunities of taking away 'superior and leaving behind inferior timbers. Consequently, the 'State endeavours to effect a wholesale bargain, and as such pur-'chasers as would buy the whole stock on a river are rare, no com-'petition is attained, and as a natural consequence, prices remain 'low. Then the purchaser insists on giving Hundis in payment for 'timbers which the State is compelled to accept for want of com-'petition ; and as it is seldom that all of such Hundis are realized 'on maturity, large sums remain outstanding, so that a number of 'uncashed Hundis is still lying in the State Treasury. It is there-'fore, in my opinion, highly important to introduce a classification 'and sales of timber in the manner in vogue with the Forest De-'partment of the Punjab.

'Large sums amounting to several lacs of rupees have been advanced *to State Forest Officials* from time to time for cutting and floating down timber from the Hills, but I think *very few of them have adjusted their accounts satisfactorily.* I would, therefore, beg to suggest that the " Adalat Tasfiya Bakaya may be instructed to collect these outstandings which the Forest Department may be able to prove against defaulters."

As usual most of the zemindars set fire to their pasture lands in the summer to secure luxuriant grass in the rainy season, and great damage ensues to the forests thereby. The present report deals with this subject and makes proposals to stop the practice for the future.

The produce of the forests of the second category is what we call minor forest produce, and a list of the articles exported is appended as given in the original, with original spelling.

" *Produce of Forests of the Second kind.*

'The produce of these Forests is of several kinds such as medi-'cinal herbs, flowers, fruits, roots, grass, &c. I may add that 'there are two kinds of forest produce.

'*First.*—Articles produced in Kashmir and its adjacent moun-'tains, and secondly, those produced in Jammu Territory, the cli-'mate of which does not materially differ from that of the Punjab.

Articles produced in Kashmir and its adjacent mountains.

1. Banafsha (violet) it grows profusely in the spring.
2. Kahzaban, it grows in rainy season.
3. Bhidana, is the seed of Quince fruit, which is abundantly cultivated in gardens, but does not grow wild so plentifully.
4. Zeera (Cumin) white and black, it grows abundantly in the Forests of Kashmir in spring.
5. Guchhian, grows in spring and rainy season.
6. Kooth, it is the root of a small plant which grows on the top of mountains and is collected in the months of Bhadoon and Assoj.
7. Kour, is dug from mountains in the rainy season.
8. Dharekari, it is a small plant, the root of which is dug out in rainy season.
9. Malin, this is a small plant which is cut in the months of Assoj, Katik, Chait and Baisakh.
10. Rasaunt, it is prepared by boiling the root of Kanbel plant.
11. Honey, is obtained from bee hives.
12. Wax, is part of the bee hives.
13. Dandasa, is the bark of Walnut and Soapnut trees.
14. Walnut, also grows wild in great abundance.
15. Unab, is a big tree and bears fruit in rainy season.
16. Soranjan, is dug from moist soil in the months of Assoj and Katik.
17. Dhup, like Kooth Root, is dug out from mountains at the close of the rainy season.
18. Harvi, is also dug from mountains as Dhup, but is a poison.
19. Wild Ginger.
20. Tuz, which is also called Bhoj Patter. In the months of Assoj and Katik, the bark of the tree is pared off.
21. Revas, grow in spring.
22. Bartang, grow in Assoj and Katik.
23. Panuk Mul, grow in Assoj and Katik.

24. Kanoucha, grow in Baisakh.
25. Warch, grow in the month of Assoj.
26. Aftimun, grow in the month of Assoj.
27. Kasus, grow in the month of Assoj
28. Ravand, (rhubarb) grow in the month of Assoj.
29. Uskhuddus.

'*Articles produced in the Jungle of the Jammu Province.*

1. Amila, it ripens in the months of Assoj and Katik.
2. Balela, this tree bears fruit in the month of Katik.
3. Halela, ditto ditto ditto
4. Ambultas, ditto ditto ditto
5. Shell Lac, is a resinous substance found on several kinds of trees.
6. Retah, Soapnut, this tree bears fruit in the months of Chit and Baisakh.
7. Anardana, fruit of wild pomegranate and is taken out in the months of Assoj and Katik.
8. Kishta, this fruit is taken from the tree in the months Jaith and Har and dried.
9. Naspal, is the peel of wild pomegranate.
10. Gillow, is a creeping plant which is cut in the months of Assoj and Katik.
11. Harmal, grow plentifully in the Forest.
12. Bill Kath, is taken out from the fruit of Bill tree in the months of Assoj and Katik.
13. Kesu, are the flowers of the Dhak tree.
14. Malkungni, is the fruit of a tree and ripens in the winter months. It is of redish colour.
15. Wawring, is also fruit ; but of a blackish colour, and ripens in winter months.
16. Taj, is the bark of a tree.
17. Meda Sak, is the bark of a tree.
18. Baroza, gum of Cheel tree.
19. Chalwa, is the fruit of Cheel tree.

Besides these there are several other sorts of fruit, such as Apples, Pears, Peaches, Soar grapes, Alucha, Mulberry, etc., which grow wild in the Forests.

'Under the existing arrangements, the Zemindars collect 'the above mentioned articles from the Forest at proper times and 'seasons of the year, and sell them at their own will ; no interfer-'ence is made by the Forest Department in their doing so and 'they have only to pay certain fees due thereon, with the excep-'tion of Kooth, Kour, Dharekari and Bhoj Patter, which are the 'State Monopolies and are therefore taken from the people 'employed for the purpose of collecting them, on payment of 'fixed wages."

We recommend the identification of these articles of Forest produce to such Punjab Forest officers as take an interest in the subject.

We note that there are large grass preserves in both Jammu and Kashmir, the grass from which is used in the State stables, but Zemindars are allowed, apparently, to graze their cattle in them on payment of dues.

We shall await with interest the future reports of the Kashmir Forest Department, and we have to thank Diwan Amar Nath for an interesting account of the present working of the Department. The financial capabilities of the Kashmir forests under such management as they have received during the past ten years are shewn in the statement accompanying the report. The result is as follows :—

Revenue.—Timber sales and a few other miscellaneous items Rs. 30,84.731-13-3.

Expenditure.—Spent on cutting and bringing down timber to depôts, salaries, and other items Rs. 14,46,808-5-6.

Thus there should have been credited to the State Treasury, as net revenue, a sum of Rs. 16,37,923-7-0, during those ten years; but, unfortunately, it appears that no less than Rs. 10,24,828-9-0, is outstanding revenue, *not yet collected;* hence the actual sum placed in the State's coffers is only Rs. 6,13,094-14-9, or about Rs. 61,300 a year, on an average, instead of a lakh and sixty thousand as it should have been. *Out of this total outstanding, one man* alone,—and let his name be immortalized in the pages of the "Forester"—owes the State over seven lakhs of rupees! A wealthy debtor is Ganesha Mall. The other debtors must be very small fry compared to him.

THE FORESTER IS ABROAD!

The Proceedings of the Royal Geographical Society for July contain a paper by Colonel Tanner of the Indian Survey Department on "Our present knowledge of the Himalayas." It ends with the following paragraph:

" As a last word I would say go by all means, very soon, before, in fact, all the beautiful trees in the land shall have been converted into Railway sleepers; visit the country before the beautiful camping grounds shaded *by trees 500 years old, such as I now* show (in pictures exhibited), shall have been improved off the slopes of the Himalayas. The forester is abroad, and, under orders which he is bound to obey, he spares nothing."

This adaptation of the old saying 'the school master is abroad' somewhat reverses its usual application. That old saying has usually been taken to mean—education is spreading—but here it seems to be applied in a rather different sense for wanton destruction of forests and camping grounds would not be the work of the 'forester' as we understand him.

We should like to ask Colonel Tanner to explain what he means and to tell us to what part of the Himalaya he refers. Very possibly, to judge by his paper, he is talking of Kashmir, and perhaps he will be glad to hear that the 'Forester is abroad' in that State now, and that an energetic Indian Forest Officer has taken the Kashmir Forest Department in hand, to produce, we may hope, some excellent results very soon. Colonel Tanner can hardly expect native hill States or even our own Government, to retain forests of old marketable deodars (we do not, of course, refer to camping grounds but to forests) absolutely intact, in order that he and others may make picturesque sketches to delight a London Society. What our own Government would do, and what we should hope all native Governments will do by degrees, is to work these forests judiciously, so that they may yield the yearly income that may justly be expected from them, at the same time as proper provision is made to ensure reproduction and their maintenance permanently as forest. You cannot make omelettes without breaking eggs and you cannot make the deodar forests give the interest on the capital stock without felling trees. Colonel Tanner should have been more specific, and avoided generalizations which may be applicable to some localities but are certainly not so everywhere.

THE NEW SUB-DIVISIONS OF LAND IN INDIA.

The Gazette of India of August, has brought us the new Resolution of Government in the Department of Revenue and Agriculture which enunciates the policy which is apparently to be followed in the future in regulating the Sub-Divisions of land, from the special point of view of the supply of forest and waste land material. It will not be uninteresting to our readers to reproduce the chief portions of the Resolution, which ought to go far to convince even the most sceptical of old Indians that

Forest Officers are not always so completely blinded by the necessities of finance and the beauties of a big surplus, to forget that the Department has higher aims than those of its balance sheet, and can, when it chooses, consider also the well-being of the agricultural community, the protection of its cattle in seasons of famine, and the necessity of managing forests as much for the supply of the agricultural population of the neighbourhood, as for the wants of the railways and the necessities of the export trade.

What is a fodder reserve? That is a question which we think must often have been asked: how often it has been satisfactorily answered, we do not know, but we do know that very hazy notions of its definition have prevailed in some quarters and that Forest Officers themselves have sometimes been at a loss to explain its meaning. If we mistake not, the first fodder reserves were those started in the N.-W. Provinces in districts otherwise devoid of forest lands, and that those areas were intended chiefly to supply grass for the Commissariat and a small amount of fuel for neighbouring villages. They were obviously and clearly 'meadows,' as distinct from 'pastures,' intended to supply cut fodder instead of grazing. Some people, however, did not hold these views of them, or did not understand the Circulars on the subject, and so failed to distinguish them from the more ordinary grazing grounds. The distinction has now happily been made clear and we are no longer likely to hear of fodder reserves in which grazing is looked opon as a possible use. The following is the text of the Resolution.

In a Resolution of March 1, 1883, the Government of India asked for the advice and co-operation of Local Governments as to the action which should be taken for the better protection of the cattle of the country during seasons of drought, and at the same time indicated the general outlines of the scheme which appeared most likely to secure the desired result.

2. This scheme, while seeking to encourage the people to store more carefully the grasses produced in their fields, and, where possible, to store hay, had for one of its principal objects the extended growth and reproduction of the fodder trees and bushes on which Indian cattle are so largely dependent for food-supply in years of scarcity. The question was asked whether in some cases land could not be purchased for the above purpose, and information was called for which would indicate how far the cattle in each district required protection, the extent of waste land available, and the best means of managing any land which could be set apart for the purpose.

3. The Government of India have now before them the replies of the Local Government and Administrations addressed, a summary of which is appended to this Resolution. It will be observed that the replies are still incomplete; but the Government of India are convinced, from a perusal of the reports now under

consideration, that the subject deserves to be further analysed and studied in greater detail before it is safe to draw any final conclusions.

4. The lands of each Province may for the purposes of this Resolution be ranged under three classes, *viz.* :—

1. Cultivation.
2. Pastures. / Fodder Reserves.
3. Forests, properly so called.

5. The Government of India accept the proposition that no impediment should be offered to the extension of permanent cultivation wherever the welfare of the agricultural communities demands it. It is only in cases in which the expansion of arable land is less profitable or—unless protected by a sufficient area of pastures, fodder reserves, and forests—is unsafe, that restriction is required. While it is true that in some richly irrigated tracts no grazing or fodder reserves, and but few forests are required, and that it is more profitable to grow what food the cattle may require in the cultivated fields, and to import timber and other forest produce needed by the population, it is equally true that in other less favoured localities the profitable continuance of agriculture depends upon the existence of grazing lands, of fuel and fodder reserves, or forests.

6. It must first be considered to what extent 'pastures,' 'fodder reserves,' and 'forests' are required in each locality in order to meet public wants and to secure the proper protection of agriculture or the full efficiency of agricultural operations; and an analysis of each district should be made in special regard to this question.

7. The next question is that of the management of areas brought under treatment in each class. The general principle which applies to all of them is that they should be permanently maintained in such a manner as to provide a maximum benefit to the adjacent population at a minimum cost to the State. Their management must, therefore, be conducted on mercantile principles, so far as these are consistent with full regard to proved and acknowledged rights. With this proviso, the produce of the areas taken under management should be disposed of at market rates to be fixed from time to time with due consideration of the local demand and supply and any other circumstances affecting the value of the produce.

8. By *pastures* are meant grazing lands from which cattle, including sheep and goats, are not to be otherwise than temporarily excluded, but which are to be brought under a definite system of management. What that system should be is a question which requires enquiry and perhaps experiment in each locality.

In some cases it may be found necessary to close lands selected as pastures against grazing during a part of the year, opening

them only when the annually recurring scarcity of fodder begins: in others a longer period will be required for the recovery of the grass, while in certain tracts it may be found expedient to divide the pasture lands into blocks, opened in rotation, in which the number of cattle admitted will be restricted in accordance with the supply of grass by the imposition of sufficiently high grazing-fees or otherwise.

The methods to be adopted will, however, vary from district to district, and the Government of India are content at present with an expression of their desire that an investigation should be set on foot and continuously maintained, and that the responsible authorities should not on the recurrence of a fodder famine in any district or tract be exposed to a charge that the requirements of the locality in connection with the maintenance of a fodder supply had not been seriously investigated and considered in each case. It is hardly necessary to add that the system of management should be such as to exclude as far as possible all interference on the part of subordinate officers.

9. *Fodder Reserves* are lands in which, while the yield of grass is improved, the growth of fodder other than grass—*e. g.*, bushes and trees edible by cattle—is promoted, and which must for the attainment of this object be, except in years of great drought, absolutely closed against grazing, the fodder being cut and collected. Their future treatment requires observation and study.

The advantages of such reserves are that under proper treatment the average supply of fodder, whether in the form of plants trees, or grasses, is larger than under the system of open grazing; that a judicious system of supplying leaves and lopped branches to cattle will maintain a continually increasing supply of fodder without injuring the bushes or trees; that the grasses will, in the form of hay or cut fodder, produce annually more food than if grazed during the period of growth; that in years of extremity when cattle are admitted to the reserves, fodder bushes and trees being able to withstand long-continued drought, afford a supply of food upon which the cattle can fall back when grasses and more shallow-rooted plants are burnt up by the heat; and, finally, that the grasses themselves will be cut and stacked so as to form a store of food when the growing vegetation in the open grounds has been exhausted.

10. By *Forests* proper are meant lands which have been set apart primarily either for the production of timber, fuel, and the other products of tree-growth, or for the protection of hill sides; but forests may also be constituted and maintained for other cognate purposes connected with the public welfare. In many cases their importance is felt beyond their immediate neighbourhood within such limits as it is possible to transport timber or other trade-products from them with profit; but they may also serve to supply the surrounding agricultural popula-

tion with fuel, small building and other wood, grass, and minor produce, and in some cases with grazing lands. It is important that, consistently with a rational treatment under which they fulfil the primary object for which they were set apart, forests should be made to supply the needs of the adjacent residents to the utmost extent.

11. The enquiries and investigations called for under this Resolution form part of the agricultural analysis which in a Resolution, dated 8th December, 1881, Agricultural Departments were required to institute. It was there laid down that Agricultural Departments should, district by district, ascertain the causes which, especially in years of drought, had tended to interfere with "agricultural efficiency," and that, when those causes had been ascertained, remedies should be suggested and, where possible, provided. The instructions contained in the paragraphs above quoted have not in some Provinces been sufficiently understood or carried into effect, and the Government of India take this opportunity of requesting that a serious commencement may now be made by Agricultural Departments in setting on foot in each district, in communication with Revenue and Forest officials, the agricultural analysis contemplated in the Resolution of 1881, so far as it includes the provision of an adequate grazing and fodder-supply.

12. The question of increasing the area of wooded land in connection with the general improvement of agriculture and the increase of the manure supply is one which it will be necessary to bring under further discussion on receipt of the final report from Dr. Voelcker, the Consulting Chemist to the Royal Agricultural Society of England. In the meantime attention is directed to the remarks on the subject contained in Dr. Voelcker's Preliminary Report, which was distributed with a Circular, dated 30th January, 1891.

13. It is, in the opinion of the Government of India, advisable for convenience of administration that all lands set apart for special treatment as pastures, fodder reserves, or forests proper should, so far as the law permits, be placed under the Forest Law as "Reserved Forests;" but it should be understood that it is not necessary that, because an area is constituted a Reserved Forest, it must be managed for the purpose of producing trees or placed under the control of the officers of the Forest Department. The method of treatment of such lands and the arrangement of their control must be regulated entirely by the local authorities, with whom remains also the power of determining the agency and system of management.

Thus we see that the Government of India is apparently in full earnest in the wish to bring all waste land not already constitued Reserved Forest, in some way under the Forest law by

sub-dividing all lands other than those set apart for cultivation and the Reserved Forests into the two great and important divisions of 'Pasture' and 'Fodder' reserves, and making all such lands as far as the law permits into' Reserved Forests.' The Government of India views should go far to dispel the notions often held that 'Reserved Forests' are lands which in some occult way or other are no longer in the same position as other lands belonging to the Government, but are somehow obstructed and held by Forest officers as their peculiar property and held by them so tight that only with difficulty may any one enter, much less cut or graze in them. As a matter of fact, a 'Reserved Forest' is only a piece of Government land in which Government has taken proper measures to ascertain and record its exact legal position regarding it, and by ascertaining and defining the easements possessed over it, to be able to say—such are our obligations, now we know where we are, we can go further and manage our land in any way we think right! And that way may be the provision of whatever supplies the Government may desire, whether of timber, or fuel, or fodder, or grazing, or anything.

And so we rejoice to read the concluding paragraph of the Government Resolution and think it right to extract once more the important phrase "it is not not necessary that because an 'area is constituted Reserved Forest, it must be managed for the 'purpose of producing trees or placed under the control of the 'Forest Department." In Madras, the Cinchona Plantations were made Reserved Forest because *first*, Government wished to know clearly what easements over the land existed, if any; and *next*, because it was advisable that the rather higher penalties for damage which the Forest Act allows should be applied; but the Forest Department has nothing to do with their management. So, too, in the North-Western Provinces, we believe we have heard that there are areas which, if not already Reserved Forest, are to be made such and used as fodder lands for the Commissariat and managed under Military control.

What is really wanted is co-operation: the Revenue officer should cease to think that Forest officers have no sympathy with the people; and the Forest officer must learn to give and take and remember that the Government must manage its forests and waste lands chief of all for the sake of its home population and their wants and that it may have other aims than a big forest surplus. There are, of course, large forests of big timber in places mostly distant from the centre of population, such as those of Burma, of the Himalaya, of the great hill ranges of Central and South India, which produce much more than local supply requires and then it is, of course, right that they should be managed so as to produce the largest amount of good material possible and the largest revenue in the interest of the reduction of other taxation; but for the poorer areas and those nearer the places of local consumption, big timber need not necessarily be aimed at, and we can

foresee a few years hence, that besides the timber and wood producing forests we shall have some areas treated under Working Plans for the supply of fodder, others for grazing, others perhaps for tanning materials and so on ; and when this takes place, we shall probably find it the result of this latest excellent order of Government.

WOOD AS FOOD.

Probably no modern science presents a wider field for speculation than that of chemistry, and more especially, perhaps, that branch of the science which treats of organic compounds, says the *Lancet*. Since the day when Wohler overthrew for ever the notion that organic substances were exclusively the products of the operation of a so-called vital force by his discovery of the synthesis of urea, a great number of bodies, hitherto obtained only in Nature's laboratory, have successfully been built up, as the result of a careful and most minute study of their exact nature.

The discovery of the preparation of substances by artifice, more particularly the dyes, has as a matter of course influenced very considerably home and foreign industries. What shall be said, then, when chemistry promises to solve hard problems of political and social economy? In an address delivered at Heidelberg, by no less eminent an authority than Victor Meyer, it is announced "that we may reasonably hope that chemistry will teach us to make the fibre of wood the source of human food." What an enormous stock of food, then, will be found if this becomes possible in the wood of our forests or even in grass and straw. The fibre of wood consists essentially of cellulin, C6, H10, O5. Can this be made to change into starch? Starch has exactly the same percentage composition, but as every one knows it differs very much in its properties and the nature of its molecule is, probably, much more complex. Cellulin is of little or no dietetic value, and it is not altered, like starch, in boiling water. It really gives glucose when treated with sulphuric acid, as is easily shown when cotton-wool, which is practically pure cellulin, is merely immersed in it. Starch gives the same product when boiled with weak acids. The author further quotes the researches of Hellreigel, which go to show beyond dispute that certain plants transform atmospheric nitrogen into albumen, and that this process can be improved by suitable treatment. The production, therefore, of starch from cellulin, together with the enforced increase of albumen in plants, would, he adds, in reality, signify the abolition of the bread question. It must be borne in mind however, that theory, fascinating and promising though it may be, is not always capable of being followed up by a practical result.—(*Timber Trades Journal.*)

SAWS.

Swage Setting, Spring Setting, Hammer Setting.

By POWIS BALE, M.I.M.E., A.M.I.C.E.

In very few things is there more difference of opinion that in sharpening and setting saws. On the present occasion we propose to discuss briefly the different methods of setting, noticing some of the advantages and disadvantages of each method.

Swage Setting.—Swage setting—called also "upsetting," "jumping," and "spreading"—is more largely practised in America than in this country. In this case clearance is obtained for the saw by widening the points of the teeth usually by means of a crotch punch arranged with two V notches, which are driven on to the points of the teeth by a hammer or weight. The second notch in the punch is rounded and spreads the teeth points out. We think this plan, especially for circular saws of stout gauge has much to commend it, more especially if the wood is cross-grained and knotty, as swaged teeth will stand up to the work, while spring-set teeth are apt to dodge the knots. Swage-set teeth will also stand a quicker feed than spring-set, all things being equal; they, however, take more power to drive—probably about 20 per cent.—and unless the setting is carefully done, ridge marks are left on the log. I think swage setting is, on the whole, more adapted for soft than hard wood.

It is claimed by the users of swage-set teeth that swaging condenses and hardens the steel at the points of the teeth; but, if this is so, with saws correctly tempered it would, I take it, be likely to be detrimental and cause the points to crumble. Another trouble found in swage-setting is the difficulty of getting perfect uniformity of set without which no saw can be pronounced to be in first rate cutting condition. Swage setting does not sharpen the teeth of the saw, as some may suppose.

When a saw is set or spread by means of a punch and a blow from a hammer, care should be taken that the points of the teeth only are spread, and that the tooth itself is not bent or strained, and that the blows given and the hammer used are not too heavy. The teeth should be carefully tried with a straight edge on both sides and points, and be exactly in line. In swage setting, should a tooth point be broken by striking a nail, it can be lengthened slightly by raising the punch or swage when in the act of setting the tooth, and the point of the tooth will be upraised, and, if not too much broken, will take its share of duty with the rest.

To "spread" set all the teeth as nearly as possible alike with a crotch punch it is necessary to regulate to a nicety the weight or strength of the blow given by the hammer. In America a tool has been introduced to do this mechanically. It consists briefly in mounting the crotch punch on the end of a tube or rod, and arranging a series of movable weights, with holes through them, to slide up and down the rod. These weights are allowed to drop on the punch, the strength of the blow being regulated according to the gauge of the saw and the amount of set required. For saws of large diameter and thick gauge, spread set can be recommended, as it is very difficult to spring set or bend the teeth of a thick saw with regularity.

SPRING SETTING.—This is perhaps the most general kind of setting, and, if regularly and carefully done, answers very well; the teeth, however, have a constant tendency to assume their original position. Saw teeth should not, under any circumstances, be set without a gauge, as it is a wasteful and stupid plan, producing rough work and more rapidly wearing out the teeth which happen to be overset. In practice it will be found that a saw perfectly set will work much freer, cut smoother, and at the same time it will waste less wood than an imperfectly set one; less set is also required on a truly and equally set saw to effect the desired clearance.

Several good mechanical saw sets, combined with gauges, are now made, and so arranged that when they are fixed to any desired set it is impossible to overset a tooth; consequently the teeth are all set exactly alike, and, if they are equal in length, each tooth gets its fair share of work, the friction of work and waste of wood of wood being reduced to a minimum. In working it is found that the teeth of a saw wear at the side of the points, and if some teeth have more set than others, these are unduly strained, and, from the severe and uneven friction, are often heated, and are inclined to buckle and run from the line. In using spring set, it is necessary to somewhat overset the saw, to compensate for the tendency of the teeth, especially when worn or dull, to spring back to their original position.

We have recently seen a very neat form of American tool for spring setting by means of a cam-lever, by which a very even set may be obtained without unduly straining the saw teeth. The operator stands behind the saw, and the set is attached to the teeth by placing a bed die on the point of the tooth to be set so that the point will project beyond the die about one-sixteenth of an inch; the cam-lever is then brought down to a stop on the cam, at the same time bending the teeth towards the latter. A four-point gauge is fitted to the lever, and it can be adjusted to any amount of set desired by means of a thumbscrew. It is claimed as an advantage of this arrangement that the bending power is exercised on the tooth between two bed bearings, so that the operator has only to bear down on the cam-lever, and the more power

he applies the tighter he fastens the set to the saw, and at the same time the bend is a curve and not an angle, and that, therefore, the saw teeth are less liable to fracture.

If a saw is allowed to get dull it will spring from the work, and increased power will be required to force it through the wood.

HAMMER SETTING.—The third system of setting we have to notice is hammer setting. The old-fashioned way of doing this was with a punch and a block of wood, and a very brutal way it was, as it strained the saw plate, and sometimes broke the teeth; at the same time it was impossible to get the teeth to one unifrom set, consequently the timber was scored and much power consumed unnecessarily. If carefully and judiciously done, hammer-set saws will stand up well to their work. The best plan with which we are acquainted is to mount the saw horizontally on a conical centre and allow the teeth to rest on an adjustable steel die made with a bevelled edge turned eccentric, so as to allow of the right proportion of set for teeth of various sizes. With this arrangement any desired amount of uniform set can be *given* to the teeth without unduly straining them or the saw plate. Hammer setting is a fair test as to the quality of the saw as the teeth may crack or fracture if the steel is burnt or of too hard a temper, or bend readily if too soft.

In conclusion, it must be borne in mind that, whatever kind of setting is employed, for successful and economical working *absolute uniformity* is imperatively necessary. If this is not secured, the work turned out is of inferior quality, and wood and power are wasted. It should also be remembered that setting does not increase the cutting power of a saw, as a saw will cut faster with little or no set provided the nature of the wood *will allow it to pass through without binding.* The amount of set required, therefore, should be carefully judged by the sawyer, and no more set employed than is absolutely necessary. For instance, in sawing wet wood a sharp saw and a fair amount of set are required, whilst for hard, knotty wood very little set should be used.—(*Timber Trades Journal.*)

THE "KITTUL" PALM OF CEYLON.

THE "Kittul" Palm of Ceylon, so valuable to the natives of the South-Western and central portions of the island, from the richness of the juice of its flower spathes in sugar, we have always regarded as not only curious but remarkably handsome in its scolloped foliage. The American publication "Garden and Forest" dealing with palms for conservatories, has the following passage:—Some of the "Fish-tail Palms" or Caryotas are very

useful and highly ornamental as small and medium sized plants, though they rapidly attain such proportions, when under suitable treatment, that they are not suited for all collections. Of the Coryotas the most common and easiest to procure are *C. urens* and *C. sobolifera*, both of which are good and also easy to manage, as they germinate from seed readily and in a short time and make rapid growth. *Caryota urens* throws up its handsome leaves on strong stems, and in a large plant they sometimes reach a length of twelve feet or more. The leaves are bi-pinnate, which is an unusual characteristic among Palms, and the pinnules are more or less wedge-shaped being from six to eight inches in length and about half that measurement in width. The ends of the pinnules are erose, this giving them an odd appearance and readily suggesting the common appellation of Fish-tail Palm, while the color of the leaf is dark green. Another peculiarity of *C. urens* is the manner in which it flowers though this process does not begin until the plant has attained its full size. It begins to flower from the centre of the top of the stems, after which the flower-spikes are produced in a succession downward nearly to the base of the trunk until the vitality of the plant is exhausted. The seeds are somewhat larger than a Bush Bean, dark brown in color and quite hard, this description applying to the seed proper after the outer fleshy rind has been removed. *C. sobolifera* is also a fine plant, and is more dwarf in growth than the preceding. It also has bipinnate leaves, which are bright green in color, and as it throws up suckers at the base of the plant, it naturally has a more bushy habit than *C. urens*. Other good representatives of this genus are *C. furfuracea* and *C. Rumphiana*, both of which are good decorativa Palms. *Acanthorrhiza stauracantha*, sometimes known as *Chamerops stauracantha*, is another fine Palm which will succeed in a moderate temperature. It has palmate leaves, deeply divided and dark green above, while the under side is covered with a silvery tomentum. A distinguishing feature of this plant is the mass of root-like spines which surround its base, and from which its generic name is derived. It is a native of Mexico, and though not very common, has been in cultivation for many years.—*(Indian Agriculturist, June 11th 1891)*.

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FORESTRY IN NORTH AMERICA.

PART II.

The portions of the Atlantic forest region, adjoining the extensive western woodless tracts, give Mayr an opportunity of considering the origin of these areas, poor in wood, but for the most part stocked with tall grasses. It may be laid down as a general statement that they are caused by the dry climate of the prairies. The author, however, rightly observes, that a great portion of the prairies of North America possesses a climate moist enough to render the existence of forest possible, and that other non-climatic causes must be considered to account for the absence of trees. This question is also discussed by Sergent in the introduction to his book which has been already referred to. The annual forest fires have destroyed the primæval forest in this region, and prevent its restoration. A zone, poor in wood, bordering along the west side of the Atlantic forest tract and separating it from the true prairie land, is described by Sergent as prairie with less than 20 per cent of forest. This zone, which to the east has a remarkable bending towards Lake Michigan, was, before the introduction of woods, limited to the damp low land protected against fire, which extended along the sides of the water-courses.

When the land was brought under cultivation, and fields took the place of grassy plains and checked the fires, the forest spread and it has therefore happened in Wisconsin, Illinois, Iowa and other States, that the forest is naturally regenerating itself in many places by seed or coppice shoots, and continually increasing in area. In Western Texas, latitude 30 degrees, extensive areas of woods of Mesquit bean *Prosopis juliflora*, had altogether disappeared owing to the annual forest fires.

Irregular underground stocks sent out shoots which were destroyed annually by the fires, and, so to speak, coppiced. Now, however, that the fires have become less frequent and severe, large areas have become re-stocked with this species, partly by seedlings and partly by coppice shoots. In a similar way in all provinces of British India on both sides of the Ganges, the forest is extending at the cost of the Savannah wherever the annual forest fires have been checked and other causes do not hinder its re-growth. Much

has also been done in several of the States by plantations, which flourish in this badly wooded country wherever the climate is sufficiently moist. What Sergent states of Kansas will illustrate the above remarks. In the eastern Counties of this State, very extensive plantations have succceeded. In the central and western parts of Kansas, however, where the climate is dry, all attempt to introduce woods have hitherto failed. Even in Missouri, east of Kansas, are a few partly wooded tracts and here the recent spread of woodland is ascribed to the law against forest grazing. (Sergent, p. 560.)

In the Northern Pine zone of the great Atlantic forest region, *Pinus Strobus*, the white pine, as it is called in America, (in Europe known as the Weymouth Pine,) is the most important species for the Forester. Formerly, chiefly mixed with broad-leaved trees, it formed enormous forest tracts from the north coast of the Gulf of St. Lawrence to northern Georgia, and westwards beyond the sources of the Missouri to the river Winnipeg. At present, the only considerable supplies of this valuable timber are to be found in Canada, its principal home, and in the United States in the Lake Districts of the States of Michigan, Wisconsin and Minnesota. These three States at present yield about 80 per cent of the white pine timber used by the United States.

It is long since the Weymouth Pine* was introduced into Europe, and it can well be said that its introduction into Germany was a lucky venture, the importance of which is not, perhaps, as yet, sufficiently recognized.

Even without considering its rapid growth, and its great production of wood, it has two extremely valuable qualities, in its prolonged cover of the soil and dense fall of needles. In the State forest of Nürnberg, every year a vast amount of forest litter must be obtained; and the Weymouth Pine would have been planted upon a large scale were not the seed so dear. Both Fernow and Mayr confirm the statement that most of the Weymouth Pine seed purchased in the United States is imported there from Europe. The exploitation of the Forests of Weymouth Pine in the lake districts is carried out on a vast scale. It is a system of pillaging the forests (Raubwirthschaft) on the greatest scale. These operations have only one object, to bring as much timber as possible out of the forest in the shortest possible time and to make money. Only the best trees are felled and the rest are destroyed by fire.

The remains of such a forest after the first forest fire has destroyed the twigs and leading and side shoots of the trees, present a remarkable appearance. Between the standing blackened and partly carbonised stems of the broad leaved and other trees which have not been felled, are the stumps of the felled pines, and

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* *Pinus Strobus* was introduced into England in 1705 and Lord Weymouth was the first to plant it out on a large scale. It may, however, have been cultivated in Paris in the 16th century. *Taxodium distichum and Juniperus virginiana* were intrcduced into Europe in the first half of the 17th century.

the ground covered with wood which would not have paid for its removal. Whatever portions of this wood do not rot, are burned by the annual fires. However, such wasted forests are not altogether without hope of recovery. In the hand of a skilful forester they could soon become productive again. We are not far off the time when, in the Lake districts, capital will be applied on a large scale for productive Forestry. At present, such devastated forests are to be had for a trifling sum, and splendid results would follow from good management. In 1880, in three Lake districts of Michigan, Wisconsin, and Minnesota there were estimated to be 7,000 million cubic feet of standing timber of Weymouth Pine, whilst in the last ten years 6,205 millicns cubic feet have been felled and exported, in 1889 alone 750 millions cubic feet. There is therefore little more left than can be exported in a single year.

Many of the large saw-mills have supplies of logs for several years, but others of them have already been obliged to stop work or to get timber from Canada.

Chicago alone, the great port to the south of Lake Michigan, which in part owes its rapid rise to the timber trade, imports yearly 161,210,000 c. ft. of wood, all of Weymouth Pine. These forests also yield other coniferous wood and quantities of broad leaved wood. As a comparison, it may here be noted that the annual yield of the Prussian State Forests is 205,800,000 cubic feet which is the annual yield of 6,750,000 acres. The forest timber yard was established in Chicago in 1834, but only by 1843 had the timber attained large proportions. Broad leaved timber was imported at an early date, but at first only in small quantities. Professor Beal (in *Garden and Forest*, 1890, p. 559) relates that he brought out from the forest logs of *Liriodendron tulipiferum* in 1880 to a country store where they were exchanged for various wares. As soon as the supplies of Weymouth Pine in North America and in Canada have been exhausted, the trade will only have the Southern Pine Forests and those of Californian redwood and of Douglas fir in the west to look to.

In the Forests of Weymouth Pine, besides broad leaved trees, there are two other pines, which are chiefly restricted to special kinds of soil :—the gray pine, *Pinus Banksiana*, preferring the poorest sandy soils, a tree of little value but widely spread, from New Brunswick and the Southern coast of Hudson's Bay to the Mackenzie River and the eastern slopes of the Rocky Mountains and southwards to lat. 65 degrees ; and the red pine, *Pinus resinosa*, a valuable similar tree formerly exported under the name of *Strobus*. Mayr says "the soil of the Weymouth 'Pine gives the best meadows ; that of the Red Pine, inferior 'wheat soil, whilst that of Banks' Pine does not repay the cost 'of clearing for cultivation." We have now to describe the northern coniferous forest, which Mayr terms the coniferous forest of the sub-arctic region, Sergent, the northern forest tract (extending in both the Atlantic and Pacific regions) and

Drude, in the work mentioned below* includes in the glacier forest tract of Alaska and British North America. This region is confined to forest bordering on the Arctic Circle in Alaska and British North America. At the summits of the Alleghanies, however, *Picea nigra* and *Abies Fraseri* are found, which belong to it. In Labrador, the forest limits do not extend beyond Lat. 60 degrees, but at the mouth of the Mackenzie river and in Alaska it extends beyond the Arctic circle, as far as Lat. 70 degrees. In the northern part of this region, the forest is thin and scattered. The white and black spruce (*Picea alba* and *nigra*) are characteristic trees, whilst the valleys and lower plains are stocked with poplars, birches, and willows. In the Pacific region, *Picea sitchensis* is found from near the coast to a distance of 50 miles from the sea. In the Atlantic region, the above-mentioned grey pine (*P. Banksiana*) extends from the eastern slopes of the Rocky Mountains to Lat. 65 degrees. This immense forest tract is poor in species; and, as already mentioned, four trees are found throughout the whole breadth of the continent. These are:—1, *Betula papyrifera*, Marshall (Canoe or paper birch) from Labrador to Alaska and from Scandinavia and Washington to British Columbia; 2, *Populus tremuloides* (Aspen) Labrador to Alaska, Pennsylvania and Kentucky to California, and in the highest parts of the Rocky Mountains to New Mexico and Arizona; 3, *Populus balsamifera* (the balsam poplar or Tacamahac) from Hudson's Bay to Alaska, New England to Washington and British Columbia; 4, *Picea alba* (white spruce) from Labrador to Alaska and from Vermont to Sitka and British Columbia.

The second principal sub-division, according to Mayr, "the Prairie" includes the eastern part of Sergent's Pacific tract and the western part of his Atlantic tract, and indeed the greatest part of the great central scantily covered plateaux and of the true Prairies. Sergent terms *Prairie*, the scantily wooded zone to the west of the Atlantic forest region, and the intermediate gradations between this and the central treeless plateau. In this zone, the forest covers less than 20 per cent of the area, and is chiefly found along the banks of the streams. In this scantily wooded region the climate is moist enough for the existence of forests, and the grass has only got the upper hand owing to annual forest fires. Dr. Mayr divides the tract he terms 'Prairie' into three longitudinal zones. The first, the high land to the east of the Rocky Mountains, sloping down towards the east. He attributes the absence of forest here, to the low relative humidity of the air, although the annual rainfall is sufficient for tree growth. Towards the east, the prairie is greatly extended by fire. As already observed, this zone includes a large portion of the scantily wooded tract termed Prairie by Sergent, who places

* Florenkarte von Nord America—Berghaus, Physicalischer Atlas, 1887, No. 60. Handbuch der Pflanzengeographie, Stuttgart, 1890, p. 435.

the west boundaries of it between 95 degrees and 100 degrees W. longitude, whilst Mayr gives 95 degrees as the western boundary of the Atlantic forest region.

The second zone contains the steppe-like tract between the Rocky Mountains and the Sierra Nevada, and its northern prolongation, the Cascade Mountains. The wide low-lands between these two mountain chains often receive only 4 inches of annual rainfall, whilst the relative humidity in the season of vegetation often sinks to 50 per cent or even 40 per cent. In this zone, fruit is only found on the higher mountainous tracts with damper climate. As a third Prairie zone, Mayr designates the prairies between coast range and Cascade range, or Sierra Nevada. Here, he states, the forest is wanting, owing to insufficient rainfall, although the relative humidity is sufficiently high. Similar tracts of Savannah are found in India in the inundated plain of the Brahmaputra. Only a few wood species can grow under these exceptional circumstances, among which is *Bombax malabaricum*, the cotton tree, which when leafless in the hot season, decks its verticillate branches with large splendid scarlet blossoms. Ricefields and forest only commence on either side of this extensive lowland when the level becomes somewhat higher.

Another kind of extensive prairie which cannot be at all explained by insufficient humidity is found on the Burmese mountains, especially on those in lat. 17 degrees to the south of the Thaungyin valley and the parallel valley of Haundraw. The valleys and plateaux and lower slopes of the hills are here stocked with a dense tract of evergreen forest; whilst the higher slopes, crests and ridges of the mountain chain, which attains an elevation of 6,500 ft., is clad with grass and ferns, chiefly *Pteris aquilina*. These mountains have a very moist climate with an annual rainfall of 197 inches and with heavy dew during the whole dry season. It is quite possible that these mountains were at one time inhabited by a cultivating tribe with much cattle, and that the forest has not since re-established itself on the abandoned clearings. As far as North America is concerned, it is clearly shown by Mayr and others that the existence of prairies depends on the distribution of precipitation in the different seasons of the year. There are however, extensive prairies or Savannahs in East India, the existence of which must be otherwise explained; and it would be useful to offer some remarks on this subject here. In the inundation tract of the Irrawaddy, for example, are extensive low-lands stocked with high grasses, 10 to 13 feet high and forming impenetrable thickets. In Pegu these Savannahs extend over about 2,000 sq. miles and in the plain of the Irrawaddy have a breadth in lat. 18 degrees of 30 miles. From June to August, they are from 3 to 6 feet deep under water. Rice cultivation is impossible, for the low rice plant cannot live under such a depth of water. The gigantic grasses, however, (several species of *Saccharum* and other *Andropogoneæ*) which form these

Savannahs flourish. A few months after the subsidence of the water, the dry season comes on; and when, in March and April, the grass is quite dry, fires rage through the country, resulting in a blackened wilderness of charred grass halms. But green shoots soon spring up from the rhizomes affording a welcome food to the immense buffalo herds of the Burmese. Relative atmospheric humidity, or amount of rainfall, has here nothing to do with the absence of forest; as these factors are the same here, for the grass lands as for the evergreen forest. Similar grassy tracts alternating with evergreen forest are found in several hilly districts of tropical India, especially on the Nilgiris or Blue mountains. The slopes of these mountains are clad with dense forests down to the plain; but on the highlands themselves, forest is restricted to depressions and steep rocky slopes. These mountains are principally inhabited by two races: the Badagas, who manure and cultivate permanently the land near their villages, but also have intermittent cultivation in other places, letting the land lie fallow for several years in succession; and the Todas, the indigenous race of the country, who do not cultivate, but keep large herds of buffaloes. The intermittent cultivation of the Badagas and the buffalo herds of the Todas afford an explanation of the wide stretches of clearing on these highlands. On the mountains between the rivers Sitang and Salwin east of Toungoo, an extensive tract of primæval forest has been destroyed by the *jhuming** of the Karens, and replaced by grass and bushes. Forest is here only found in valleys, and ravines, or on steep rocky slopes. Also beyond the tropics, in the Khasia hills south of the Brahmaputra, extensive grass tracts occur, as well as on the lower ranges of the North-Western Himalaya at 5,000 to 8,000 feet elevation as Mayr has noticed. Mayr is inclined to ascribe the prevalence of such grass tracts to annual forest fires, but though this explanation will suffice in many cases, it is not always sufficient, and other causes must sometimes be looked for. The Savannahs in the plains of the Irrawaddy, Sitang, Salween and other rivers of further India, depend on the protracted deep inundations to which their tracts are subject in summer. The bare uplands of the Nilgiris, as well as the meadows of the southern Schwartzwald are the results of pasturage and extensive and intermittent cultivation. Part of the prairies of North-America, as well as many extensive Savannahs at the foot of the eastern Himalayas, are due to the annual forest fires of the dry season. As regards the bare slopes of the outer North West Himalayas it may be remarked that on the mountain chains which separate the valleys of the Sutlej and Giri, as well as those between the Tons and Jumna rivers, at altitudes between

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* **Jhuming is a kind of intermittent cultivation by cutting down and burning forest or grass land, which lies fallow for periods of 5—10 years with intervals of 2 years cultivation.**

6,500 and 10,000 feet the cooler northern sides of the mountains are forest clad, whilst the southern slopes, which are exposed to the moist south winds are only covered with grass. The question between forest and grass is not so easily settled as one might think. The third chief Sub-Division, which Mayr terms the North Mexican forest region, is confined to the Mountains of New Mexico and Arizona. He distinguishes between the sub-tropical and moderately warm regions. In the former, which extends to an altitude of 6,000 feet, lightly wooded forests, consisting chiefly of Mexican Cypresses are found on the northern slopes, whilst branchy, short stemmed evergreen oaks form little woods along the banks of streams and in damp valleys. The Mesquit bean (*Prosopis juliflora*) is characteristic of the lower, hot and dry regions. In Southern Arizona it attains a height of 50 feet and the knotty stem a diameter averaging one metre, but occasionally it only becomes 20 feet high or may even be like a bush.

In spring, even before the rain has fallen, its delicate, feathered green foliage forms the chief ornament of the dried up areas and its wood yields the fuel of this region. In the neighbouring Mexican province of Sonora, the Mesquit bean is kept down, and even its twigs lopped off for fuel. Hence a thick underground base with strong roots developes, which may be considered an underground forest, as they dig it up for fuel. (Mayr p. 232.) Similar action is taken in Texas, and as in these districts of North America, so in the Savannahs of Northern India; at the foot of the Himalayas, the Sal and other trees form a shapeless knotty often large stool, when he annual shoots are yearly burned off by the forest fires. *Yucca baccata* forms the strangest kind of tree in these dry regions, named the Bayonet tree, a Palm lily, attaining a height of 40 feet, with long leaves 1½ feet long and shaped like bayonets, in tufts at the terminal shoots of the stem and of the few branches; also *Cereus giganteus*, the giant cactus, attains a height of 60 feet and 2 feet diameter.

On the higher mountains, in the North-eastern part of Arizona and in New Mexico, are extensive park-like forests, which stretch along the Rocky Mountains far to the north.

In these forests, three important members of the Pacific forest flora are found:—(1). *Pseudotsuga Douglasii*, which is also found further south on the Mexican Mountains, but in Arizona only attains a height of 80-120 feet with a diameter of 3-4 feet. (2) *Pinus ponderosa*, a true auxiliary of the Douglas fir, which is named the yellow pine in California and Oregon, from the yellowish green of its needles, three in a sheath, which are 3½ to 7½ inches long. (3.) *Abies concolor*, Lindley and Gordon, the Balsam fir.

It must here be mentioned that extensive forests belonging to the North Mexican Forest region passes into this class of Forest on the higher parts of the Rocky Mountains and the mountains between them and the Sierra Nevada.

They are included in the region termed Pacific tract by Sergent. One might distinguish the greater part of it as a middle region lying between the Atlantic and Pacific tracts and possessing forty-six characteristic species. Sergent includes it in the Pacific tract, as most of the species in it belong to the latter. *Cercocarpus ledifolius*, a Rosaceous tree, known as mountain mahogany with hard red heart-wood taking a fine polish; *Quercus undulata*; *Picea Engelmanni*, a Pitch spruce which, in Colorado, forms extensive valuable forests between 8,000 to 10,000 feet altitude, and a few pines; *Pinus edulis*, with great, wingless edible seeds, known as *Piñon*; and *Pinus monophylla*, the one needled pine, may be referred to as examples of the characteristic species of this middle region. These forests are mostly very light and often interrupted by large treeless stretches. In the greater part of it, the climate is dry, but precipitation in the Southern Rocky Mountains is fairly abundant. The forest in this region is not undisturbed: on the contrary, the best wood has long ago been felled for the great mines, for railways and for other purposes. The great Atlantic and Pacific railway passes for 21 miles through what was once a splendid coniferous forest on the San Francisco Mountains, but which is now, for the most part, annihilated.

In the Pacific Forest region, Dr. Mayr distinguishes four regions, the sub-tropical forest, the forest of the moderately hot region, the coniferous forest of the temperate region and the alpine conifers; but here it must suffice to refer to the red wood forests of *Sequoia sempervirens*, along the coast mountains of California and the Douglas fir forests in Oregon and Washington. The coast Sequoias are confined to a district with a warm, very damp climate, and so "permeated with humidity 'is the rich sandy loam in which this tree attains its full 'dimensions, that the removal of heavy logs must be done 'on sledges which, with broad slides slip along the slimy soil." 'The following is the description of a wood which, according to 'Mayr's opinion, represents the still virgin redwood "Forest. About '57 stems to the acre, with a mean growth of 22½ feet 'and an average height of 275 feet, giving 3,350 cubic feet of log 'timber per tree, or 190,000 cubic feet per acre." The average age of this wood is estimated by Mayr to be 703 years, so that the average annual increment per acre is 270 cubic feet. These are large figures. However, Dr. Mayr's data are not obtained by careful measurement of sample areas of average quality, but he considers them reliable average figures, and we have no ground for disbelieving his estimates. Let us compare them with the yield of forests in the Black Forest. In the famous forest range of Pfalzgrafenweiler in Wurttemberg there are silver-fir woods with a mixture of beech, 152 stems per acre, which, at an age of 150 years, with a mean height of 130 feet contain 18,550 cubic feet of

timber, or an annual increment in 150 years of 123 cubic feet per acre, considerably less than half Dr. Mayr's figures for an age of 700 years of *Sequoia sempervirens*. Occasionally this species attains still greater dimensions. Dr. Mayr found a stem is a sheltered valley 308 feet high with a girth of 46·6 feet at 6½ feet from the ground. The first great green branches began at 230 feet up the stem or 65 feet higher than the tallest tree in Germany. Still greater dimensions are attained by the giant Sequoias in the valleys to the west of Sierra Nevada, but the tree has only a circumscribed range. Semler, p. 591, writes as follows :—" Deeper in the mountains than the small groups so often described which are found in Calaveras county, the Mammoth tree extends over an area of 44 English square miles but never forms such an enormous mass of forest as the Redwood." In *Garden and Forest*, 1890, p. 571, is a description of Forest and of patches of this tree lying more to the south, especially in Tulare county with a collective area estimated at 37,500 acres in Oregon, Washington and in the coast mountains of British Columbia.

Here the yearly precipitation of snow and rain is about 63 inches* and dense coats of moss lay on the branches of the Douglas fir and other accompanying conifers. The average height of mature trees is here 213 feet and the thickness about 6½ feet diameter at 6½ feet from the ground. These are average dimensions, but stems over 300 feet high are not uncommon. A young 80 year old wood on the best sandy loam rich in humus in South Oregon (Mayr, p. 297) of quite uniform dense growth, a so-called secondary growth springing from a clearing made by a former forest fire, gives, with a height of 130 feet and 324 stems per acre 58,600 cubic feet of timber per acre or a mean annual increment up to an age of 80 years of 735 cubic feet. In this case also would a complete valuation of a carefully chosen sample area have been of the greatest interest. The great part of these woods is, however, already in the hands of the wood merchants and will soon be turned into money. The State still owns 9,000 acres, of which 3,500 have been demarcated as a reserve and are protected by law.

Sequoia sempervirens reproduces itself easily as coppice, as stated by Semler p. 593 and Kessler, p. 726. Kessler, p. 598 makes a similar statement regarding the Mexican Cypress, *Taxodium Mexicanum*. The coast Sequoia yields almost exclusively the building timber for California, and it is exported to a distance by ships and rail into the poorly wooded districts. But the stock is rapidly disappearing and the wood of the Douglas fir and of the yellow pine from Oregon are invading the district formerly monopolized by the Sequoia.

Among the numerous conifers which grow northwards from

* Mayr in Forest and Jagdzeitung, 1886, p. 61.

California into the coast districts, the Douglas fir *Pseudotsuga Douglasii* is the most important. This most valuable of all North American forest trees is at its best on the declivities and damp valleys of the Cascade mountains. Dr. Mayr's figures are only results from a careful estimation by eye, passed on the measurement of single trees of average dimensions. Nevertheless even these imperfect results give us some means of picturing to ourselves the enormous energy of forest growth under these extremely favourable conditions of soil and climate. Spruce woods of the best quality in Württemberg* eighty years old with 320 stems per acre and an average height of 91 feet give a cubic contents of 11,650 cubic feet or a mean annual increment up to this age of 145 cubic feet per acre.

What an immense difference in the power of roots and leaves and cambium cells to form wood quickly! In one case 735 cubic feet per acre per annum, in the other 145. Examples of such a rapid formation of wood are of the highest scientific interest in order to get a foresight of the time during which the formation of the coal layers in different parts of our globe were forming. If the new, but vigorously developing Forest administration in Japan would give us yield tables of *Cryptomeria japonica*, and other rapid growing forest trees in that country, we might perhaps get similar results. Up to the present time, the only trustworthy measurements giving anything like similar results are those which D. E. Hutchins, now Conservator of Forests in the eastern part of Cape Colony, made in 1882 in the plantations of *Eucalyptus Globulus*, on the Nilgiri mountains of the India Peninsula, in a similar damp mild climate to that of the Douglas fir region. A wood 19 years old, Aramby, at 7,500 feet above sea level with 500 stems per acre and a mean height of 108 feet had a volume of 9,030 cubic feet or thus gave a mean annual increment up to an age of 19 years of 477 cubic feet per acre.

The Douglas fir has not only the property of producing wood in a most extraordinarily rapid manner, when the climate thoroughly suits it, but also can accommodate itself wonderfully to different climatic conditions. It is still an extremely valuable forest tree in the dry climate of Montana, on the mountains which there form the water parting between the Pacific and Atlantic oceans. Towards the south, it extends, as already stated, into the mountains of Texas, Arizona, and northern Mexico up to 30 degrees in latitude, whilst its northern limit is lat. 55 degrees. In Montana, according to Mayr, the annual rainfall is only 23½ inches and here its growth is considerably slower, and the dimensions of the trees smaller than in the damp climate of the mountains of the coast. Mayr gives the mean height and diameter here at

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* Lorey, Ertragsuntersuchungen in Fichtenbeständen.—Forst und Jagdzeitung. Supplementary Vol. XII. p. 54.

148 feet and 32 inches with a slow growth. These facts correspond to the habit of the Deodar in its home in the North West Himalayas, where in the damp climate of the outer ranges with a mean annual rainfall of 70 inches it attains a diameter of 24 inches in 80 years, whilst in the dry climate of the inner ranges of the Himalayas it requiries 200 years to arrive at these dimensions

The yellow pine has almost the same habit as the Douglas fir, and its wood is exported in vast masses from the eastern part of Washington, from Montana, Oregon and Idaho. Unless protection be afforded, these forests of the Douglas fir, of the yellow pine and other conifers will be annihilated: here, as in the the pine forests of the eastern coast regions, there are wonderfully large business concerns which are appropriating the colossal timber resources produced by centuries. The wood cutter is followed by the forest fire, which destroys what is left of the forest. Everywhere, up to the present time, the forest of North America is devastated, and thoughtful observers have for a long time raised the question how long the timber supplies will hold out. Attempts have frequently been made to estimate the annual demands for wood in the United States, and in the summary prepared by Fernow (p. 35) for the Paris Exhibition, it has been placed at 22,000 million cubic feet and the total forest area at 695,000 square miles. If all the wood which is felled were utilized, this would yield an annual supply of 50 cubic ft. per acre with good management. But only a small part of the wood, perhaps on the average only half what is felled, often only a quarter or less, the rest remains lying on the ground and is generally burnt up by the forest fires. Thus, in case a careful management were introduced, and the area of forests did not steadily diminish, each acre must produce annually 100 cubic ft. and this is a very high yield.

If these figures are reliable, the production of wood must soon fall off and a crisis cannot be long delayed. One cannot, however, imagine, that any speedy alteration will be made in the present system of pillage and destruction of the forest. The time will come and cannot be much longer delayed, when the export of wood from the United States, which has steadily diminished of late, must altogether cease, and the import from Canada, already considerable, will be greatly increased. Many even consider it is not impossible that the export of wood from Europe to America will in time become profitable. The development of affairs will lead to a larger use of stone and iron instead of timber for buildings; whilst in many districts, coal will replace wood fuel, for at present three quarters of the total consumption of wood is for fuel. But, if the question progresses as rapidly as at present, the prices of wood must steadily increase and this is recognised on all sides. Laws against destruction of forests by fire have for a long time been in force in the different States, but have for the most part been

treated as a dead letter. In 1882, the American Forest Association was founded, which meets every year and has already done much to awaken interest in forest preservation in wide circles. In California, there is a State Board of Forestry, to arrest destruction of the forests, and in some of the Prairie States, already considerable areas have been planted out, extending to 100,000 acres in Dakota, and 1,000,000 acres in Nebraska. On the other hand we must not forget, that in other States, the forest area has become greatly contracted. For example, Ohio contained 54 per cent of Forest in 1856, and in 1887 only 16·69 per cent. From New York we learn that the Government of this State will undertake the proper management of the Forest region of the *Adirondacks* which, since 1886, has been under the protection of a special law and also that the President of the United States will take some decisive step towards forest protection, provided the state of the political parties will permit his doing so.

For the scientific observation of forests much has been done in the United States. The Central Government has published the excellent works of Sergent, and the publication of a new work 'The Sylva of North America' has just begun, which will set forth the description of North American trees in 12 quarto volumes with excellent illustrations. In the Museum of New York State, on the 15th of last November, the large collections of woods and forest products, known as the Jessup collection, was opened. Accounts of North American Forest regions are published in books and periodicals. The interests of the Timber Trade are dealt with in several periodicals some of which are well edited. Only one thing is wanting and that is indeed the chief point, an intelligent, permanent system of Forest management.

The Forest area, which still belongs to the Central Government, is estimated at 720 millions of acres, more than six times the area of all state and domain Forests in the German Empire. But for the present, the endeavour to become rich, rapidly carries the day. The wood speculator finds ways and means to fell wood in forests belonging to the States and to the Union, and the owner of private forests has not yet learnt that regular management may, indeed, give less produce at first than pillage, but that in a properly managed forest, a large wood capital collects which can at once yield a certain revenue, sure to increase steadily with the increasing prices of wood. Many wait for the State to commence and start regular management in its own forests. The State has, however, as yet hesitated to enforce its rights in its own forests with energy, partly from consideration for the wood merchants who are exploiting the forests regardless of consequences. By the law of homesteads, every American citizen can obtain 64 acres for a trifling stamp duty and just as much more for the small price of $1\frac{1}{4}$—$2\frac{1}{2}$ dollars an acre. Kessler relates that the Humboldt Redwood Company obtained 5,000 acres for 18 to 20,000 dollars by buying the

rights of settlers at the rate of 50 dollars a head. The value of the wood on this area has been estimated at 11 million dollars. But enormous masses of wood are felled every year on State lands without the shadow of a right. In the seven years from 1881 to 1887 the value of wood felled in this way, amounted to 36,719,935 dollars, of which only a small part, 478,000 dollars was recovered from the guilty parties.

The interests of the present are stronger than the care for the future. Whilst this is also the case in other countries, yet it has been possible to take care to ensure the rights of the future. When in India in 1856, energetic measures were taken to secure the rights of the State in the Teak forests of Pegu, and a proper forest management was introduced, the greatest possible dissatisfaction was shown by the merchants of Rangoon. It would have been a proper policy, they urged, to bring all mature timber to the market as soon as possible, so as to secure a rapid development to the young seaport. At one time it seemed as if the urgent petitions of the commercial people at Rangoon to the British East Indian Government, would be granted. Most fortunately, such a bad measure was avoided, the Teak forests were protected, a permanent well-regulated management was introduced, and it is now universally admitted that these thorough measures have greatly contributed to further the continual and *rapid development of Rangoon.*

In America also, in course of time, the rights of futurity will be protected. It is chiefly through Germans that successful forest management has been introduced into India and it is not impossible that before the import of German wood into America commences, skilful German Foresters will be invited to establish a rational forest utilization and a careful forest treatment into the United States. At present, however, the fulfilment of that idea lies in the distant future ; and we must not forget that already in 1882, Bernhard Fernow in a letter from North America warned his fellow foresters in Germany not to build hopes on prospects in the United States. But in America, a change in affairs may come in a single night and signs are not wanting that such a change may before very long become possible. In a certain place in his book, p. 97, Mayr says, "At present the revenues of a properly managed forest would be very small and would 'not nearly defray the cost of management. Precisely because the 'commencement would involve a loss, the State appears to be 'specially designated to make a beginning ; the time will soon 'come in which land stocked with forest will experience a similar 'rise in value as the once valueless Prairie." Whether the Federal Government, or that of separate States, will actually start the work, appears, as things are at present, very doubtful. It is not, however, impossible, that private forest owners will grasp the fact of the great advantage of careful forest management. With steadily rising prices for wood, the increasing capital value will

afford a more than sufficient compensation for the moderate revenue from a well managed forest. In another place, where he speaks of the Douglas fir, Dr. Mayr very properly says; "how 'well enterprise and capital might unite in a *simple system* 'based on a steady profit, to the blessing of the land and the 'profit of the speculator." It is not impossible that, in the United States, the private forest owner may first carry out this idea. The rapid growth of several of the most valuable woods of North America and the steady rise in the price of wood will render it possible to carry out careful forest management at a profit.

COOPER'S HILL COLLEGE, W. R. FISHER.
3rd May, 1891.

THE "THAN" TREE OF THE UPPER BURMA FORESTS.

Mr. Oliver, Conservator of Forests, Upper Burma, has lately sent me specimens of a new species of Terminalia which will shortly be figured in Hooker's Icones Plantarum as *Terminalia Oliveri*. Mr. H. C. Hill has given me some additional information concerning the appearance and geographical distribution of this interesting tree, which he has permitted me to incorporate in the following remarks.

The Burmese name is "Than," and the tree belongs to the section Pentaptera which by some Botanists has been regarded as a separate genus. The fruit is five winged, like that of the common *Terminalia tomentosa*, but much smaller. The leaves are sub-opposite, at least in the few specimens which I have, as yet, seen; and this circumstance, together with the small size of the fruit, explains why Government Officers in Burma were doubtful whether the tree should be classed under *Combretum* or under *Terminalia*. It has no petals: petals, however, are wanting also in *Combretum apetalum*, a Burmese species. Besides the absence of petals, the chief generic character of *Terminalia* is that the cotyledons are always convolute, whereas in most species of *Combretum* they are irregularly plaited or flat. The cotyledons of Than are spirally convolute, in the upper part of the seed being twisted around the radicula, which has about one third the length of the embryo. It stands very near to two species described by Presl from the Philippine Islands, *Terminalia passiflora*, with a two winged fruit and *polyantha*, the fruit of which has four, sometimes three wings.

Than is a moderate sized tree, attaining 40-50 ft. with a girth 4-5 ft. The stem is irregularly shaped, often channeled, somewhat like that of the Hornbeam of Europe. During the dry season the leaves turn red before falling. The bark, which is greenish grey, resembling that of *Anogeissus latifolia*, is thick and brittle. Its cells contain an abundance of starch and of calcium oxalate crystals, but apparently no tannin. The decoction of the bark gives a light colored extract, which has been largely used to adulterate Cutch, but is believed to be entirely ineffective as a tanning material.

Terminalia Oliveri is a very common tree in the dry region of Upper Burma, which commences on both sides of the Irrawaddy river, north of the 19th degree N. lat. and which extends as far as Mandalay and somewhat higher up in the Chindwin valley and in the country between the Chindwin and the Irrawaddy river. In this extensive dry region, which also comprises some of the land drained by the upper Sitang river, with a mean annual rainfall of only 20-30 inches, Than is associated with Cutch (*Acacia Catechu*) in a thin open forest, from which the Cutch, being the more valuable tree, has been much cut out. Other trees found in this forest are: *Tectona Hamiltoniana, Shorea Siamensis* (Ingyin) and (Taukyan) *Terminalia tomentosa.*

D. BRANDIS.

Bonn, July, 1891.

LORD WENLOCK ON THE FOREST POLICY OF BELLARY.

In reply to a petition presented to the Governor of Madras at Hospet, when on tour in the Bellary District, to the effect that the "relaxation of the Forest Laws and especially the free use 'of brushwood for sugar cane boiling and for agricultural 'purposes generally, are measures earnestly and widely desired," His Excellency Lord Wenlock replied as follows:—

"They had also asked for the relaxation of the forest laws as 'regards the use of brushwood for sugar cane boiling and agricul- 'tural purposes. His Excellency was afraid on this point it was 'hardly possible for the Government to make exceptions in favour 'of one particular industry. He thought the sugar-cane industry 'hardly required any special prop or bolstering up by the Govern- 'ment. He did not think it possible for the Government to relax 'any of the rules laid down by it. As regards local industry, he 'found on enquiry that the prices charged were the same which 'the Department charged in the other provinces. He did not

'think it would be possible to reduce them still lower for the sake 'of agricultural interests. If it were found possible to do so, he 'would like to see it done, but at the same time he felt bound to 'say that the Government had a difficult task before it in conserv-'ing the forests of the country. There was no doubt that unless 'matters were taken in hand in time, the whole forest would have 'been denuded both of fuel and fodder. At present he did not 'think it possible to relax the laws which were found necessary 'for the conservation of forests. His Excellency did not think a 'Government would be doing its duty if it did not do its best for 'the interests of the country and in the interests of those who came 'after them. To do so they must have revenue and it was found 'that they were obliged to charge certain fees and take certain 'privileges for acquiring a certain amount of forest produce which 'would eventually prove a source of enormous wealth to the people 'of the country. He looked forward to the time, not very far 'distant, he hoped, when the forest revenues would have grown 'so large as to enable the Government to reduce very largely the 'taxation which pressed so hardly on the subjects of the Queen in 'this country. He hoped that day was not far distant, perhaps in 'the life time of some of those assembled there. As matters stood 'at present he could only say it was difficult for the Government 'to relax any of the rules and regulations which were found neces-'sary to carry on the forestry of the country."

We are glad to see that Lord Wenlock has refused to give way in this case and has been able to explain so clearly to the petitioners, the forest policy of his Government, a policy which was inaugurated by his predecessor, Sir M. E. Grant Duff. The sugar cultivators are among the richest and most prosperous members of the agricultural community, and if among the cultivators on the rich and well irrigated banks of the Toongabudra there are any who can afford to pay fully for the forest produce they require, it is they. It may seem to those who do not know Bellary that the concession of free brushwood to poorer agriculturists might not only be graceful but be useful to the forests as allowing of cheap 'cleanings' of poor material, the brushwood taken in such cases being usually thorny bushes of Zizyphus, Canthium, Carissa and so on, which, if the other growth is good, may be usefully removed. But the fact is that in the neighbourhood of Hospet the Reserved Forests are of the poorest character as regards vegetation, and require chiefly the protection of all growth for a period of years to shelter the shoots and seedlings of the forest trees. With full protection for five to ten years, the Gound, Hospet, Jog, Tornagal, Billakal and Buckasagar Reserves, which now consist of bare hill-sides with a little grass and an occasional bush or stunted tree, or of piles of granitic boulders with a few pockets of soil and occasional shrubs, will change their character and fill up. They ought really to be walled or fenced to make sure of protection, and we think that the result would be such a growth of various kinds that after

a time, the yearly 'cleanings' which will be necessary to re-relieve the tree shoots will give plenty of good fencing material of the kind most in use in the country. But, as pointed out by Lord Wenlock, it is perfectly fair and just that the agriculturists for whose benefit the expense of forest protection and improvement is incurred, should contribute towards that expense by paying for the material they consume.

It is really wonderful what capabilities these dry stony Deccan hills have. In ravines, not far from Hospet, we have found patches of pure teak, which, in spite of yearly burning and yearly hacking, still comes up again and again; and with protection would give, if not timber, at any rate, material for small native houses and agricultural implements. Teak and Yegi (Pterocarpus Marsupium); Yepi (Hardwickia binata), Narudu (Dolichandrone crispa) with Gyrocarpus Jacquini, Terminalia tomentosa and Belerica and the male bamboo, may be expected to form the future forest, and there will, as in the neighbouring leased forests of Sandúr, be probably a fair sprinkling of sandal gradually introduced. We believe there are few forest works in India which so deserve to be watched with interest by Forest Officers as the work of gradually restoring and reclothing the barren hills of Bellary and Anantapur. Hitherto, Ajmere has been our type of excellent results, but much of the good done there has, as Mr. Hill recently told us, been counterbalanced by the evil effects of a too early opening to grazing. To judge by Lord Wenlock's speech, the Madras authorities may be trusted to avoid the Ajmere mistakes, and arrange for both necessities, the necessity of good pasture and that of cheap fuel and agricultural material in such a manner as to prevent the one necessity injuring the prospects of the other. The recent orders of the Government of India separating the 'pasture lands' from those required for 'fuel and fodder' shews that the distinction is intended to be maintained: and, if we mistake not, merely reproduces and applies more generally, what had already been applied under what is known in Madras as the 'Bellary scheme.'

DEODAR CONING IN ENGLAND.

Reverting to this subject, we may note that the earliest record we can find of the Deodar coning in Europe is of one that fruited in 1852, at Mr. Kell Barclay's, at Bury Hill, near Dorking, as recorded in our columns, September 11, 1852, p. 582. The tree was at that time 28 feet high. We should be glad to know its further history. Since then it has fruited at Dropmore, Kew, Sunninghill, and other places. Sir Joseph Hooker kindly reminds us that at Kew there is a specimen tree which was a seedling raised by the late Sir Thomas Acland from a cone produced at Killerton, near Exeter. The tree is more vigorous than many of the Deodars grown at Kew, the species not thriving well in the Royal Gardens. Writing from Bicton in our columns in December 11, 1869, Mr. James Barnes, says :—" I have not yet seen a tree 'above fifty years old or more than 80 feet high, though I 'have known it to produce cones for years; and have seen per'fect seed produced from home-grown plants, as well as plants 'raised from home-grown seed."—*Gardener's Chronicle.*

TASMANIAN TIMBERS.

Among the important trees of Tasmania is the "blue gum" which has its home principally in the southern parts of Tasmania. Many of these trees exceed a height of 280 ft., with a girth of from 40 to 50 ft. The timber of the blue gum is of rather a pale colour hard, heavy, strong, and durable. In transverse strain its strength is about equal to English oak. It is used in house and shipbuilding, and also by carriage builders and manufacturers of tools. The timber of the peppermint tree is useful for many kinds of carpenters' work; in drying it does not split. It is also used in shipbuilding. The "stringy bark gum" is a valuable tree, found in abundance in Tasmania. The wood supplies a large portion of the ordinary sawn hard timber for rough building purposes. It is also well adapted for carriage, cart, and wagon-building, wheelwork, and agricultural machinery, as well as for the framing of railway carriages and trucks. The timber of the "white gum" or "manna tree," is used for shingles, rails, and rough building materials. The "iron bark" is a valuable tree, the trunk of which is sawn into good timber, it is also used for posts and rails. One of the most handsome of the native trees is the 'blackwood," which is widely distributed along the slopes of the north-west coast. The timber is of a brownish colour, closely striped with streaks of various shades of a reddish brown. The more ornamented logs of this wood are exceedingly beautiful, and fetch a high price. The myrtle or beech is common in Tasmania, and forms a large proportion of the forests. The "huon" pine is said to be the grandest and most useful of all the

soft woods. It is abundant along the rivers of the south-western parts of the island, attaining a height of from 60 to 120 ft., with a diameter from 3 to 8 ft. It is largely employed, locally, for all kinds of furniture and ornamental work, and is the most highly-esteemed of all kinds of wood for the lighter sea craft. The value of Tasmanian bark and timber exported during the last five years amounted £627,361, or an average of about £125,472 a year. This, says the *Journal of the Society of Arts*, represents nearly one-eleventh of the total exports.—*Timber Trades Journal.*

AN INTERESTING FOSSIL.

The other morning the navvies working at the deep cutting of the Crieff and Comrie Railway, at the west side of the town, came upon a curious heavy stone lying about 8 ft. below the surface of the ground. On examination, it seemed to have been a root-cutting of a tree nearly a foot in length, having a diameter at the lower end of 7 in., and at the top of 5 in. The lower-end appears as if cut with an axe or some such instrument, and the top has every appearance of being cut with a saw, and is quite smooth. The various yearly growths are distinctly visible at the smooth end. An experienced wood merchant is of opinion that it is the cutting of a laburnum tree. It is much heavier than a stone of the same size would be.—*Ibid.*

THE MANNER OF MANNA.

In an Occasional Note which we published on the 17th instant it was remarked that "the manna which fell from the sky during a shower near Merdui and Diarbekir, in Asia Minor, last August, and was baked into bread, has been examined by French men of science. It is in the form of little balls or hailstones, yellow outside and white within, and is identified as a lichen belonging to the species *Lecanora esculenta.* The lichen is found in Algeria, but is common on the arid mountains of Tartary and the Kirghiz Desert." A correspondent who read the note has kindly sent us some manna for inspection. In doing so he writes :—"Perhaps you would like to see some of it? So I enclose a small quantity. As to manna it does occasionally fall in the form of snow in the vicinity of Mardin, as I have repeatedly been assured by competent and trustworthy witnesses. I also tested it; but it is totally different from the recent fall in colour, form and taste. The former assimilates what we would realise the scriptural manna to have been like." The sample resembles Plaster of Paris, the shape and colour being the same as described in the note above. Curiously enough, the same post brought us a recently published *brochure* on the chemical properties of mannas from

the pen of Mr. David Hooper, F. C. S., the Madras Government Quinologist. It is written in scientific phraselogy, and though it affords a deal of information on this interesting subject from the chemist's point of view, it does not condescend to go into those details which the " general reader" is in need of.

It is as well to disabuse one's mind at once of the idea that there is anything miraculous about manna. Doubtless the passage in the Old Testament, describing how this " angels' food" was rained down from heaven to keep from starvation the wandering Israelites, pre-supposes the idea that a miracle was performed thereby; but the miracle, if any, was with respect to the quantity of food provided rather than to the substance of the food itself. Mannas (for there are several varieties) are simply concrete exudations from plants and trees and they are found more conspicuously in the following species:—Ash, cotoneaster, tamarisk, camelthorn, eucalyptus, oak, plantain, willow, cedar, larch and pine. The manna of the Israelites, according to some authorities, was obtained from the tamarisk shrub, according to others from the camelthorn. It may well have been obtained from both. Tamarisk manna is called by the Persians guz-angubin or tamarisk honey. It exudes during the day time in the hot months of June and July, from the slender branches of the plant, in the form of honey-like drops which in the cool of the morning are found in a solid state. Ehrenberg discovered that the exudation of this manna is caused by insects of the genus Coccus which sometimes cover the branches. At the present day it is eaten by the Arabs and by the monks of Mount Sinai like honey with their bread. The camelthorn (or alhagi) manna is called by the Persians *tar-angubin*. The plant from which it exudes is small, and leguminous, growing commonly enough in Persia, Afghanistan and Beluchistan. The manna occurs in the form of small, roundish, hard, dry tears varying in size from a mustard seed to that of a coriander, of light brown colour, sweet taste and senna-like odour. It is collected near Candahar and Herat and imported into India from Cabul and Candahar to the extent of about 2,000 lbs. annually, and is valued at about thirty shillings a pound. Though each of these two kinds of manna has claims to be considered identical with the manna of the Israelites, we cannot help thinking that at least one other kind has equal claims. This is the manna lichen mentioned above, which is found in more or less abundance in every desert place between Algiers and Tartary. The *Lecanora esculenta* is a plant that trails along the ground in layers of three to six inches thick over large tracts of country, and the position of its manna on the ground tallies with that mentioned in the Bible narrative.

The manna best known in Indian Bazaars is " Shirkhist," derived from the *Cotoneaster nummularia* and chiefly imported, we believe, from Afghanistan and Turkestan. It is curious that its chemistry had not been correctly ascertained until the year

before last, when M. Raby examined an authentic specimen from Persia. The author of *Makhzan-el-Adwiya,* speaking of shirkhist, says "they say that in the town of the Subbah of Behar and Patna and Bhagalpore; a substance like shirkhist is obtained from a plant called in Hindi, *katra,* and they prepare it in this manner. The tree is cut down and fire applied to the roots, which causes a flow of boiling juice which concretes into lumps like white sugar sweetmeats, and this sugar has all the properties of shirkist, and it is called by the people of those parts "*harlalu.*" Of another kind of manna, Mr. Hooper writes as follows:—"The pines and the cedars in the Himalayas have this year been thickly covered with manna, and Dr. G. Watt last February supplied some of the young branches of *Pinus excelsa* coated with a white saccharine exudation matting together the acicular leaves. The manna was whitish, opaque, soft and clammy to the touch before it was dried, odourless and sweet." There is no necessity to describe in detail the numerous other kinds of mannas. Amongst them may be mentioned the commercial manna from the *frassinetti,* or plantations of Sicily, which is useful for its medicinal properties; Ispahani manna derived from the *Astragalus florulentus*; oak manna derived from the twigs of the *Quercus persica,* which is an object of some industry among the tribes of Kurdistan at the present day; Laristan manna which oozes from the *Pyrus glabra*; Australian eucalyptus manna, which is such a favorite sweetmeat with the children of that country; and the *manna de Briançon* or Birgantina, collected from the larches grown on the French Alps. *(Indian Agriculturist.)*

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FOREST TREATMENT IN SOUTH TINNEVELLY.

Tinnevelly forms the southernmost district of the Madras Presidency and occupies an area of 5381 square miles. Its principal forest areas occupy the eastern slopes of the range of hills which forms the western boundary of the district and is roughly taken at 900,000 acres. The mean annual rainfall in the plains may be estimated at 30, and that on the hills at 100 inches. Deciduous forests occupy all the drier slopes up to an elevation of 2,000 feet and from this elevation great masses of evergreen forests, broken only by ruined patches of Karni clearings, stretch themselves upward to the crests of the range and along the streams at the bottom of valleys. A line of cairns which runs more or less midway along the slopes, separates the "Reserved Lands," which lie below, from the "Reserved Forests" which lie above it. In the former, free grazing and the removal of headloads of grass and firewood for *bonâ fide* home use are allowed; but in the latter no such privileges exist.

South Tinnevelly comprises the taluqs of Nanguneri, and Ambasamudram; but my remarks will chiefly apply to Papanasam which is by far the principal block in the district. The forest area, although very limited and the field for work not large, has, still, much in it that is interesting. The sacred waters of the Tambaraparni and other rivers take their rise here, and it is the irrigation they afford which is the principal source of wealth to the district; fairly good fishing and shooting are obtained, and the richness and variety of the vegetation are well known.

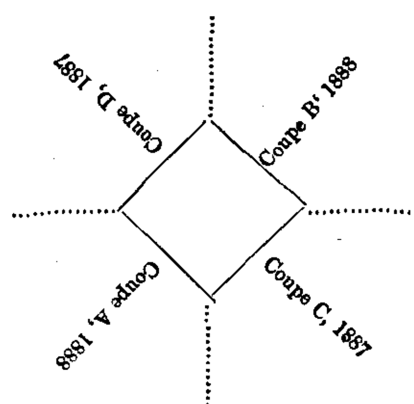
The forests were formerly worked under the "License" and "Selection" systems and more recently "Coppice under standards," "Jardinage," and cultural operations were introduced.

LICENSE SYSTEM:—*This was applied to the lower deciduous* forests and was confined to the removal of firewood, agricultural implements and small timber. It may be briefly described as follows. The *purchaser* on payment of a fee receives from the *issuer* a ticket which prescribes the period and locality, the description and amount of produce, and the thanna through which the

produce must pass. At the thanna the produce is checked and if it accords with the terms of the ticket, the ticket is retained and in exchange a "way permit" is given, which covers the produce to its place of destination. It will be at once seen that this is a wasteful and ruinous system. Under it the best trees are selected and removed and crooked, gnarled, dwarfed and rejected trees remain which must only deteriorate the forests and reduce their value and utility; or perhaps out of a felled tree a small portion of the trunk or a branch is taken and the rest allowed to rot or removed for some other less useful purpose. This system has given way to the "Coppice under standards" system.

COPPICE UNDER STANDARDS:—An attempt at this system was made the year previous on small irregular patches, but it was not understood and it proved a financial failure.

The Mundanthorai plateau, which is about 10 square miles, was then chosen, as it is centrally situated and affords easy access to the foresters and forest guards of the range for studying the system and applying it to their own charges. A base line was first laid out along the Mundanthorai-Kariar Road and from this parallel lines were taken 15 chains apart, then across these, at right-angles, another row of lines were cut at 20 chains apart, thereby dividing up the area into 30 acre coupes so arranged that the winds which blow with great force for nearly four months in the year cut the coupes more or less at right-angles to their greater length. The coupes are demarcated with stones, showing the number or name of the coupe and the year in which the coupe was felled, thus:—



(The angle of the stones shows the direction of the coupe boundary line, and each face of the stone points to the cut area and has inscribed on it the name of the coupe and the year in which it was cut.)

The principal trees and shrubs found within the plateau are Teak, Pterocarpus Marsupium, Satinwood, Tamarind, Grewia tiliæfolia, abutilifolia and asiatica, Briedelia retusa, Cordia Myxa and angustifolia, Cassia Fistula, Albizzia odoratissima, Lebbek and amara, Spondias mangifera, Hemigyrosa canescens and deficiens, Schleichera trijuga, Diospyros Embryopteris and Melanoxylon, Careya arborea, Zizyphus Jujuba and xylopyra, Anogeissus latifolia, Dalbergia latifolia, paniculata and lanceolaria, Premna latifolia, Morinda citrifolia, Chionanthus malabarica, Sapindus emarginatus, Walsura piscidia, Aglaia, minutiflora, Atalantia monophylla, Limonia alata, Mundulea suberosa, Buchanania latifolia, Terminalia Chebula, Arjuna and belerica, Vitex altissima and trifolia, Mimusops indica and Roxburghiana, Cycas revoluta, Gyrocarpus Jacquini, Givotia rottleriformis, Bauhinia malabarica and tomentosa, Hydnocarpus alpina, Hardwickia binata and pinnata, Phyllanthus Emblica and polyphyllus, with dense extensive patches of undergrowth consisting mostly of Strobilanthes Kunthianus, Memecylon tinctorium, Randia dumetorum, Webera asiatica, Flacourtia sepiaria, Erythroxylon indicum, Dichrostachys cinerea, Zizyphus Œnoplia, Helicteres Isora, Actephila excelsa and Cadaba triphylla.

Most of the trees and shrubs coppice well and send out strong, vigorous shoots, and in the case of Dalbergia paniculata it was here discovered, as was noticed in the 1888 September number of the *Indian Forester*, that coppice shoots spring from the parenchyma between the woody zones, a fact unknown in other dicotyledonous plants.

I am indebted to J. G. F. M. for his "A note on Forest Management in Tinnevelly" published in the January-March number of the *Indian Forester* where he has given in much detail the "signal advantages" gained by the system, but a short account from one who had introduced the system and laid out the. coupes, may not be out of place.

The fellings were done departmentally, but might now be given out on contract, except for the fact that small branches and twigs are removed in headloads by the poorer class of villagers, mostly women, from the sale of which they just scrape a day's living. It would be exceedingly hard to leave them to the tender mercies of a contractor. I have not an account of the out-turn of produce with me, but the net gain at the end of the official year 1888-89 was something near Rs. 25 per acre, with a prospect of being very materially increased. From 10 to 20 standards, according to the richness or poorness of the soil and the denseness of the undergrowth, were left per acre. On fairly extensive slopes of 1 in 10 and steeper, it was found advisable to retain the continuity of the leaf canopy and the fellings approached more an improvement—thinning and cleaning operation than regular coppice; care being taken to improve the stock, prevent erosion and maintain high forest. The regrowth

from stools and the reproduction from self-sown seed were very good, owing of course to the greater amount and better quality of seeds produced by the parent trees, caused by the admission of more light all around them and by the breaking of the surface and the lodgement of the seed direct into the mineral soil by the felling, conversion and transport operations.

The average height of the teak shoots for the first year was 5 feet and the girth 2·5 inches. For the other species it was somewhat less.

The only dangers to be encountered are from the winds which blow with great force for nearly four months in the year; from the Sambur and from insects. The effect of wind is mitigated by cutting the coupes as is now done in alternate strips. The Sambur selects the soft corky bark of the *Mundulea Suberosa* and of satinwood saplings for rubbing his horns against, and those saplings thus attacked are generally very much damaged and eventually produce heartshakes which, in the case of satinwood, unfit it for the naves of wheels for which it is much used and especially valued. The trees may be protected by fencing them round with, or hanging round their bark from 2 to 4 feet high Prickly Pear or any other thorny shrub.

Coppice under standards is now introduced throughout the district with very good results, both financially and as a means of improving and regenerating the low deciduous forests. With the data now at hand a working plan might easily be drawn up and strictly adhered to.

The Tinnevelly "*Selection System*" much resembled License system in that it allowed the Contractor to pick and its choose the trees for felling over an extensive area and resulted in the dead, dying, hollow, and stag-headed trees, being left behind. This method has since given place to "Jardinage" or the "selection method" properly understood.

Jardinage:—This method is applied to the evergreen forests or "Sholas" and to trees of special value in the upper deciduous and semi-evergreen forests. The Sholas require most careful treatment as on their existence depends the continuance of the water-supply to the rivers and streams. We have just begun to mark out coupes and to work them systematically and with a view to the above purpose (namely, the insurance of the water-supply to the rivers and streams). The points in view were:—

(1) *The continuity of the leaf canopy.* Just ripe, over-ripe and dying trees were removed at the rate of one tree per two acres.

(2.) *The improvement of individual trees* by cutting away from them the creepers and Loranthus.

(3) *The germination of seeds of the more important species*, such as Kongu, which was assisted by cutting away the brushwood and raking up the ground immediately after a goodly

number of seeds had fallen; *and fostering of seedlings and saplings* by cleanings and the removal of cover so that they might eventually take the place of the fallen veterans.

In the abandoned Karni clearings, seedlings of the principal indigenous species were planted out and are mentioned under cultural operations.

Of the principal shola trees I may mention Hopea Wightiana (Vella Kongu), which is par excellence the timber of Tinnevelly, Balanocarpus utile (Karun Kongu), Aglaia Roxburghiana (Chockla), Gluta travancorica (Shenkurani), Cullenia excelsa (Vedipela), Bassia latifolia (Malai Ilupai), Hardwickia pinnata (Yanai Kolavu) Pterospermum rubiginosum (Sitalapolavu), Heritiera Papilio (Santhana Unnu), Cedrela Toona (Mathacaree Vembu), Diospyros calycina (Thovara), D. Ebenum (Karuthali), Myristica laurifolia (Katujadica), M. corticosa (Kakamungi), Alstonia scholaris (Thundapalai), Vitex altissima (Milay), Bischoffia javanica (Mala Chadiyan), Mesua ferrea (Nangu), Litsœa zeylanica (Shembugapala), Acrocarpus fraxinifolius (Mala Konnai), Euphoria Longana (Puvan) and Filicium decipiens.

Notes on the out-turn from conversion, and the reducing factors of some of the principal Classes of trees were taken, but are mislaid. I shall try to supply them later on.

CULTURAL OPERATIONS:—These were formerly confined to grassy areas through which narrow parallel lines were cut and teak and vengai (Pterocarpus Marsupium) seeds were dibbled in. It was always so far as I am aware, a failure.

Considering the importance of the evergreen forests both as a means of insuring the water-supply of the Tambaraparni and other rivers and financially from the large revenue obtained from them, it had always occured to me to extend these forests which already have been very much contracted by the unlimited Karni or Kumri clearings, which are now for the most part abandoned and consist of low, dense, tangled, shrubby growth. With this view, permanent nurseries were made at Kannikally Odei and Ullaar and seedlings of the principal species such as Kongu, Satinwood, &c., were raised in them and put out on the abandoned Karni clearings (sites of Sholas cleared for cultivation) in parallel contour lines during the first burst of the North East and South West monsoons in the form of an *introduction*. Teak and Vengai (trees of deciduous forests) were put out into the more open places, and black and white Kongu, Nangu and other "Shade loving" species into shady places. Seeds also were dibbled in, but this was chiefly done by the Watchers and Forest Guards who carried seeds in their waist cloths and dibbled them in, in their beats, during the rains, in exposed and burnt up places.

It may be mentioned that the areas were first cleared of all creepers and tangled growth and that the introduced plants were freed from vertical covering and wherever self-sown seedlings and saplings of the principal species were found it was merely cleaned

around them so as to protected them against suppression.

In addition to the plants obtained from the nurseries I was able to obtain 1,000 Checkla, 2,000 Nangu, and 2,000 Kongu seedlings from self-sown seeds in the forests. These were taken out and planted in November, 1888.

I had just six months to watch the results of these operations which extended over an area of 50 acres, but during that time I noticed that the majority of the plants were established and doing well. It will of course be necessary to replant failures and to clean the areas occasionally.

S. C. MOSS.

THE EXTERMINATION OF WILD BEASTS IN THE CENTRAL PROVINCES.

From time to time a statement appears in the Indian papers showing the number of persons that have been killed by wild beasts and by snakebite during some preceding period of twelve months. This number, if we remember rightly, generally remains fairly constant at some 20,000 head. And English papers get hold of these figures and taking them in good faith, publish heart-rending articles on this terrible mortality. But there is good reason to believe that the number of deaths from snakebite at least is not to be relied on, as many deaths, such as those from heart disease, or in some cases from poisoning, are attributed to that cause. Still, when all allowances are made for error, the number remains sufficiently large.

A recent Resolution published by the Chief Commissioner of the Central Provinces dwells on this subject at some length. It appears that in 1890, the number of persons killed by wild animals in the C. P. was 368, and the number of deaths said to be due to snakebite was 1041, the total loss of human life being 14 more than in 1889.

The ravages due to wolves in the Hoshangabad, Saugor, and Narsinghpur districts, and the measures successfully adopted for the destruction of these pests have already been described in some of the Indian papers. It will suffice it to say here that 87 deaths were due to this cause and that the pack has been entirely exterminated, owing to the systematic arrangements of the special officer deputed for that purpose.

Various man-eating tigers have been destroyed : one in the Raipur district for which a reward of Rs. 300 was offered ; another in Bhandara ; besides several in Hoshangabad, Chanda, Balaghat, and Seoni. In all, about seven or eight man-eaters have been satisfactorily accounted for. Panthers claim 26 victims.

The number of cattle reported to have been killed by wild beasts is 4620 against 3390 in 1889. These figures however do not pretend to accuracy, as a change has been made in the manner of preparing the returns, and cattle which have strayed and have then been stolen are often reported as carried off by wild beasts. It is believed that wild dogs in some districts have destroyed a good many cattle.

The number of gun licenses in operation was 13,426, a large increase on the figures for 1889; and the Commissioner of the Nerbudda Division observes that there is no lack of arms, but rather of efficient Shikaris.

The next part of the Resolution deals with two suggestions made by the Government of India the first of which relates to rewards. "The scale of ordinary rewards now in force in the 'Central Provinces for the destruction of wild animals is as 'follows :—

'For tigers	..	...	Rs.	50
" do. cubs	...	...	"	20
" man-eating tigers	...	...	"	100
" panthers and leopards	...	...	"	10
" do. do. cubs	...	...	"	5
" bears	...	...	"	5
" do. cubs	...	...	"	2
" wolves	...	...	"	2
" any wolf, haunting villages and seizing children			"	5
" wolf cubs	...	...	As.	8
" hyenas	...	...	Rs.	5
" do. cubs	...	...	As.	8

"In the case of man-eating panthers and wolves, and of man-'eating tigers, for the destruction of which the ordinary reward of 'Rs. 100 is found insufficient, special rewards are sanctioned, as 'occasion requires, and these have sometimes been as much as 'Rs. 500. The general opinion is that in most respects this scale 'is sufficiently liberal, and the Chief Commissioner would prefer 'not to alter it at present or until he has had further experience of 'its operation."

The rewards are paid either by the Deputy Commissioner, in the case of animals for which special rewards have been sanctioned, and also in the case of wolves and wolf cubs; or at the nearest Tahsili or Police Station. The skins are sent in to head quarters along with the bill "to prevent fraud," and of course the shikari never sees his skin again. In some provinces we believe the custom is to mark the skin in such a manner as to prevent its being brought up a second time, and then to return it to the owner. The Deputy Commissioner had to inspect the skins of wolves himself owing to frauds perpetrated by the passing off of jackal skins instead of the real article.

The second suggestion made by the Government of India is so interesting to us as Foresters, that we do not apologize for

quoting what the Resolution says about it at length. The suggestion is that "shooting parties should be encouraged for the destruction of tigers and other dangerous carnivora in reserved forests, 'and that in addition to liberal rewards, assistance in the way 'of elephants should be freely given to Military officers and others 'who have leisure to organize shooting-parties for the destruction 'of advertised man-eaters. In connection with the general subject 'of Forest administration, the Chief Commissioner has recently had 'occasion to consider the Forest Shooting Rules in force in these 'Provinces. These rules were first officially published in November 1888. They were subsequently modified, and in these Rules 'no person other than Forest officers or Military officers below the 'rank of Field Officer may *shoot in a reserved forest at any time* 'without a permit, for which* a fee is charged; while in closed or fire-protected forests, no shooting is allowed between the 1st January and 30th June. Practically the effect of the Rules should be to close the Government Forests, 'which cover something over 20,000 square miles of country, 'to Native Shikaris—who, if inferior marksmen, are still our 'most efficient, because by far the most numerous agency 'for destroying wild animals; and to convert these forests '—that is one-fourth of the entire khalsa area of the Province—into preserves for wild beasts. Enquiries have been 'made as to the effect of these Rules in increasing the number '*of wild animals: and from the information acquired, as well as* 'from his perception of the bearing and tendency of the Rules 'themselves, the Chief Commissioner is satisfied that the Rules 'tend to protect, and as a matter of fact do protect, wild animals 'and augment their numbers. The Shooting Rules came into operation in November 1888: and since then there has been, as the figures in the margin show, a progressive and extraordinary decrease in the number of wild animals destroyed. This result is, in the opinion of some officers, chiefly produced by the prohibitive effect which the heavy license fees have on Native Shikaris who *cannot afford to pay the fees, and to whom* consequently the Government Forests are permanently closed. Other officers of 'sporting tastes, holding that Native Shikaris are inferior marksmen, view with satisfaction their exclusion from reserved forests, 'and think that this exclusion will result in fewer tigers 'being merely maimed and wounded, and through inability to catch 'their natural prey, becoming man-eaters. Other officers 'again who think that Native Shikaris never shoot tigers, 'but reserve themselves for deer and pig, find in these Rules an 'effective measure of protection for deer and pig, the legitimate

Year.		*Wild* animals killep.
1888	...	1,825
1889	...	1,223
1890	...	1,000

* Military officers below the rank of Field Officer are granted permits free of charge.

'prey of the tiger, which being thus, it is presumed, provided with 'an abundance of food, has no need to turn man-eater. Finally, 'the Commissioner of a Division, a mighty hunter, ingeniously puts 'in a good word for the tigers: "If," he says, "tigers are all des-'troyed, the damage which will then be caused (by deer and pig) 'to the crops in the villages lying in the vicinity of the forests 'will become a very serious matter, and be much more severely felt 'than the loss of a few cattle"! But against these sportsman-'like and, therefore, seductive arguments, the Chief Commissioner's 'official judgment is proof. Indeed, he regards them as testimony 'to the protective effect of the Rules, and as pleas for preserving 'large game in the vast forests of the Central Provinces. But 'Mr. MacDonnell, having in mind the long tale of loss to life and 'property which the present and all previous reports disclose, thinks 'that our object should be to rid the Province of destructive wild 'animals, and in the pursuit of this object he finds it difficult to 'make a distinction between wild animals which are destructive to 'life and those which are merely destructive to crops. The present 'Shooting Rules were, it is understood, introduced primarily with 'the object of Forest conservancy, and there was the subsidiary 'object of preventing the extinction of some species of birds and 'animals. The preservation of destructive canivora was, the Chief 'Commissioner believes, neither desired nor contemplated. But 'the rules have had this unforeseen effect, while there is every 'reason to think that the requirements of Forest conservancy will 'be sufficiently met by less restrictive measures.

"In May last the Chief Commissioner had an opportunity of 'bringing the matter before a Conference of Forest and Executive 'officers assembled to consider certain questions of Forest 'administration. The Conference comprised among its members 'some of the best sportsmen and most accomplished naturalists in 'the Province, and the unanimous opinion of these officers was that 'the Shooting Rules needed amendment. An amended draft of 'the Rules was submitted for the Chief Commissioner's orders, 'and this draft he has since been carefully considering. There are 'certain points, particularly in connection with a close season for 'game birds and for some animals, on which Mr. MacDonnell has 'still some enquiries to make; but his disposition is to accept the 'chief provisions of the modified rules substantially as submitted to 'him. Broadly speaking, their effect will be to allow greater free-'dom of the chase, unrestricted by fees; or even by license, except 'in those fire-protected or specially reserved forests in which for 'reasons of public utility it is essential to maintain the license 'system. Even here, provision will be made, whereby, subject to 'safe-guards in the interests of Forest protection, all carnivorous 'animals may be hunted down and killed. As stated by Colonel 'Bloomfield, Deputy Commissioner of Narsinghpur, himself a good 'sportsman (who has now, however, exchanged his hunting grounds 'in the Central Provinces for well-earned retirement in England,)

'the shooting in and general hustling of Government Reserved 'Forests will soon diminish the supply of large carnivora."

It is worth while pausing h re to consider the views of the district officers consulted. It is evident that Native Shikaris have not been able to pay the high fees demanded and that the number of wild animals killed has largely decreased in a period of three years, a decrease amounting to 45 per cent. Some officers think that there will be fewer man-eaters in the future, either because there will be fewer tigers mained by inferior native marksmen or because there will be more deer and pig for the tigers to eat. Another officer is of opinion that if too many tigers are shot down, pig and deer will increase to such an alarming degree that the villagers' crops will suffer.

Whatever the ingenious reason set forth may be they one and all view with satisfaction the exclusion of the Native Shikari, and yet there is another way of looking at the question and it is simply this, the more the Native Shikari is kept out of the reserved forest the greater chance will the district officer and his friends have of adding to their bag when they themselves take the field. We are glad to see that "against these seductive 'arguments, the Chief Commissioner's Official judgment is proof," and that in future the forests not specially fire-protected will be thrown open to sportsman of any creed or colour. The question of Forest Conservancy and shooting rules, or game rules, is too long to discourse now, and we hope to take it up at some future time. It is quite clear that the stringent rules adopted a short time ago in the C. P. and now about to be relaxed, are contrary to the spirit of the age, and that some method of opening the forests to legitimate sport consistent with their preservation from fire must be the object sought for.

S.

MY FIRST TIGER.

Your readers have probably seen this heading two or three times already, but as other peoples' first tigers were not related to my first tiger, it still possesses the charm of novelty, as far as I am concerned. The manner in which he was converted into an ornament for the drawing room was as follows. As I was opening my letters one morning, I come across a demi-official looking cover which contained a report of the death of a would-be shikari at the hands, or rather claws, of an infuriated tiger. Two native shikaris had spent a pleasant evening in a "machan" over a pool of water, and by the light of a waning moon had put a bullet into Mr. Stripes' shoulder; Stripes roared, the Shikaris shivered, and Stripes' mother came up to enquire into the cause of the bad language her son was using; when she saw him going on three legs, she used such fearful expressions that the "machan" shook with the agitation of the shikaris, unused as they were to anything stronger than the ordinary polite language of a native village. Mrs. Stripes helped her son back to the cover of the jungle, and silence reigned around the "machan" where the shikaris sat and shivered till sunrise, when, with rapid steps and many a glance over their shoulder, they made tracks for the nearest human habitation. There, about twenty men soon collected, and our shikaris, whose courage and imagination had been warmed by the sun, told their tale: the tiger was an enormous one, and the tigress still larger; their roars had shaken the hills; the tiger was mortally wounded and was certainly dead by this time; were they going to lose the sircar reward or were they going to show their courage by tracking a dead tiger and skinning him; and were they not twenty to one, and he a corpse! Armed with antiquated spears, guns more dangerous to the shooter than the shot at, billhooks and axes, they started in quest of the dead beast. Arrived at the "machan," their eagerness for the fray began to diminish, they spoke in whispers and kept sharp eyes on the surrounding jungle; but blood was plentiful on the track, and no tiger could lose so much blood and live, so their spirits rose and they followed the trail gaily for a mile and a half, by which time they had grown careless in the absolute certainty that they would find nothing but a lifeless mass at end. In this they, were mistaken, for with a sudden roar, a crash and a spring, Stripes stood among them; they scattered like mice before a cat,

but Stripes was two quick for one of them; he caught him by the waist and quietly carried him to the foot of a tree, among the upper branches of which two of the beaters had taken refuge; they were unarmed. but yelled and shouted, and others in other trees did likewise, while some of the most distant slipped off their perches picked up their guns and fired them in the air. The general din had the desired effect; Stripes left his victim and slipped away to cover, where he was left in peace; the man was fearfully mauled, but still alive; his companions did what they could for him and carried him back to his village where he died an hour later.

My correspondent only gave me an outline of the story, and finished up with an appeal to me to send down somebody to shoot a man-eating tiger as nobody dared go into the jungle until he was accounted for.

I threw the letter across the table to M. who perused and returned it in silence: even when I asked him if he was "game," his only reply was a withering look and slight curl of his upper lip, so I said no more. It was three days before we could get away, but at last we found ourselves in a small inspection shed within a couple of miles of the ravine which had been the scene of the catastrophe already related. A consultation with some old native shikaris followed; how were we to get at Stripes, or obtain evidence of his death? No elephants were available, so we must walk, and walk circumspectly as the jungle was thick, and the tiger if alive was likely to be a dangerous customer. It would be useless driving cows in, for they would bolt at the first tigery sniff brought on the breeze; buffaloes would be better, but there were none in the adjoining villages; goats, said an old shikari, will do the trick; if the tiger is dead they will walk up to him and give tongue: if he is alive he will take one; the others will bolt, but we shall track him by the blood of the one he takes. Now, although I should have been exceedingly pleased if Stripes had been able and willing to slay ten thousand goats, I was loth to countenance the admission of those universal exterminators into a reserved forest, but without goats, not a man would come with us to show us the ravine, so reluctantly I gave orders for the goats to be brought and marched in. They behaved beautifully; walked along steadily, till we reached the entrance to the ravine; then spread out like a line of beaters and walked through the thick jungle; we had about a dozen native shikaris with us, and they showed no desire to lead the way; we visited the scene of the tragedy, found one shoe and a sanguinary cloth on the ground, and walked on for about 100 yards; we had come over a mile and a half with our rifles at full cock, and every nerve strained, through thick jungle in which a tiger might have lain within five yards of us without being seen, and had just emerged into more open ground when the goats stampeded; instantly a babel of voices broke out in the tops of the trees behind us, and looking

round, we discovered most of our shikaris well out of harm's way and looking anything but happy; two or three however stood their ground, and as soon as it was evident that Stripes was not following the goats, we walked cautiously round to where the stampede had commenced. Stripes heard us coming, and carried his goat off into a thicket before we could catch sight of him, but the fresh blood still sliding down the blades of grass showed that we were not far behind; we sat down and smoked a cigarette each, waiting for the other men to come up; then cautiously approached the thicket and walking along the edge tried to see into it. We had not gone twenty yards when we saw the dead goat about 20 feet from the edge; Stripes was invisible though he must have been sitting there while we were enjoying our smokes. A small "machan" was soon fixed up about fifteen yards from the kill, and ten feet from the ground, and there we took our seats with one native shikari, whose sharp eyes and ears we thought would be useful. For an hour and a half we sat there, and the discomfort was awful; first one leg went to sleep, and the least attempt to move it produced a variety of creaky noises; then the other leg followed suit; finally I felt that I must move, and slowly I leant back till my head rested against a leafy pillow. I woke up suddenly finding the shikari's hand on my shoulder; he was trembling from head to foot, and I was thankful that we had not allowed him to bring a gun with him; his eyes were nearly starting out of his head as he pointed with a drunkard's hand to a loophole on my left; I tried to rise silently but he signalled me back, and from the motion of his hand I understood that the tiger was walking round the machan on his way back to the goat; as soon as the shikari's hand showed that Stripes had his tail towards me, I raised myself slowly to a sitting posture; M. looked round and shook his head, then got his eye in a line with his sights again. A twig broke; then another; then a huge paw appeared under the brushwood six feet beyond the goat; then a whisker, a nose, another paw, and a head. Bang, bang, went our expresses, and a cloud of smoke shut out the view for what seemed half an hour, though really two seconds would have covered it. When the air cleared, stripes was lying "all of a heap" and the "coup de grace" which I intended for his head caught him in the shoulder which was about the only part of him visible. He took it very quietly; neither moved nor spoke; in spite of which we deemed it wise to take precautions, M. covering the carcase with his rifle while I descended to terra firma, when I did likewise for him; we approached cautiously, and heaved half a brick at his Majesty's nose; it caught him fair on the bridge, without producing any visible or audible effect on his temper. We had already signalled for the other shikaris, and as soon as they came up, stripes was dragged out and measured; seven feet nine inches from nose to tip of tail, and twenty one inches round his fore leg; he was hoisted on two poles and we started back for

camp. I almost forgot to add that he was not the wounded beast we were after, but we took it for granted that that one had died from the effects of his wounds. Now, will some old shikari tell me *how* to measure a tiger; should the tape be held taut, or made to follow every curve of the animal's back ? My measurement was with the tape held taut; later on, after his skin had been removed and laid out, it measured ten feet six inches, and I then began to understood the possibility of twelve feet tigers.

TSEROFSKI.

THE CULTIVATION OF RICE IN ITALY.

We have received Bulletin No. 21 of the Agricultural Department of Madras on the '*Cultivation of Rice in Italy*,' being extracts from an Italian official report translated by Mr. C. J. Peters, Executive Engineer, P. W. Department, S. Arcot.

We are told that the average area under rice in Italy is 498,463 acres, two-thirds of which is in the valley of the Po., and that the average outturn is nearly 40 bushels per acre, though the total production is steadily on the decrease. The following account of the history of rice cultivation is interesting.

History of rice cultivation.

"Rice (Oryza sativa of Linnæus) was supposed to come from Orissa, whence its name. The earliest mention of rice is found in the tragedies of Sophocles. It is supposed to have been introduced 'for the first time into Europe by the Greeks of Alexandria. It was 'an article of commerce from India when the Roman empire was 'at its zenith. Its cultivation was first introduced into Spain in 'the eighth century and into Italy in the tenth, but it was not culti-'vated largely until the fifteenth century, when the excavation of 'canals commenced. In 1523, it is recorded that the town and 'Marquis of Saluzzo suppressed rice cultivation in their territories 'owing to a pestilence which depopulated the town and country. 'From this time the Government began to make laws regulating 'the distribution of water and the distance of rice-fields from habi-'tations. In 1595, the Venetian Republic ordered the destruction 'of all rice-fields established after 1556, seeing that their previous 'injunctions to restrict the cultivation had been disregarded. The 'Spanish and Milanese Governments continually issued proclama-'tions, regulating the distance of rice-fields from habitations, re-'markable for the extraordinary number of penalties, always 'threatened, hardly ever enacted. One of the most important 'proclamations is that of Governor Gusman Ponce de Leon of 7th 'November, 1662, fixing the distances from the principal centres of 'population under penalty of fines and corporal punishment at the 'discretion of the Governor.

"In spite of these restrictions, rice cultivation extended, 'favoured by the introduction of productive varieties and improved 'methods and the excavation of canals, until the opening of the 'Cavour system doubled the cultivation in Piedmont."

In the matter of the processes of cultivation there is not much to say, for they differ but little from those practised in India; but the cultivators in Italy are careful to establish a good rotation and grow as alternate crops oats, wheat clover, and meadow grasses, leaving the land fallow occasionally. The disease called 'brusone' which is a rust of the genus 'Pleospora' often does considerable damage if there is irregular weather in summer, or where the soil is poor.

SERICULTURE IN ASSAM.

From the most ancient records available, we have abundant evidence that the rearing of silk-worms has formerly been carried on in almost the whole length and breadth of the Province. The food supplies of such species of worms as are only semi-domesticated are unlimited, and the climate, in most districts, is admirably suited for the growth of foods for the domesticated kinds of worms, as also for the wild worms themselves. At the present time the industry is carried on in a most desultory fashion, and the cultivation of that most appreciated, namely, the *Bombyx Mori*, is almost extinct. From cloths still obtainable, occasionally, the arts of both rearing and weaving must have attained a very high standard, but the *jogis*, or professional weavers, are daily getting fewer and fewer. Among the wealthier class of Assamese, *jogis* and descendants of original professionals, are still to be found working as common household menials, and only practising their calling occasionally, as the garments of the ladies of the household require renewing, or new garments are required for any forthcoming wedding. Till within the last 20 years, a system very analogous to slavery was in force in the province, and for a small advance of a few rupees, required perhaps to discharge a pressing claim, or a wedding-feast, a man and his family would enter into

bondage "*pur et simple,*" his creditor master agreeing to allow him "*howlat,*" *i. e.*, an advance of as many pice as he, the latter, might deem sufficient for any little extravagance, such as a new loin cloth, or an extra chittack of oil to rub over his body when musquitoes and flies are numerous, or for opium, and to supply him with rice and salt from the household stores. The bondsman's labour was debited against such advances, but all the rest that was supplied was credited with an accumulating interest beyond the man's power of arithmetically checking or disputing, so that the small original advance in the course of a few years hung not only over the parents, but on their progeny's grand-children. The introduction of tea-planting and the subsequent restrictions as to the length of period a contract to labor might be lawfully entered into, offered opportunities to many to obtain advances so as to release themselves from their former bond-holders, and it is probable that the bulk of the professional *jogis* have merged into agriculturists.

At the present day the largest quantity of silk produced in the province, is that called *Eria* or *Rhindi*, obtained from the *Attacus Ricini*, which is fed within doors on the castor-oil plant, *Ricinus Commumis.* This plant grows in the villager's garden with hardly any care, but if the seed falls or is sown on the inevitable dung-heap it grows luxuriantly; so freely does it thrive, that the Assamese with their natural indolence, do not even take the trouble to select and sow those varieties of the plant whose leaves, from their enormous size, would supply food for four and five times the number of worms that they are at present able to rear. During the season, which lasts from the very beginning to the end of the rains and during which some seven crops of cocoons are reared, villagers having worms are frequently under the necessity of buying the leaves from their neighbours. When the worms have first emerged from the eggs, the tenderest and consequently the youngest leaves are necessary, and to assist their mastication, these are torn into shreds by the hand, lest the juices should be affected or deteriorated by any steel or iron knife, but when the worms have thrown off all but their last coat or skin, they will greedily devour mature leaves. From some superstitious idea, the droppings of the worms are daily thrown out on to the nearest road or pathway. For purposes of propagation, when the female moths emerge from the cocoon, they are placed in bundles of grass stalks about ¾ inch in diameter and about 15 to 18 inches long, and males join them as soon as they have stretched their wings after emerging. Several hundreds of these bundles of grass suspended from a bamboo stretching across a room in a darkened hut, each with its 8 or 10 couples of moths, measuring 7 and 8 inches across, from tips of wings, present, to say the least, a curious spectacle. The males, after some five or six days, drop off, and within a few days die, while the females deposit eggs each to the number of 200 to 300 on the grass stalks and then expire.—So simple is the culti-

vation of this species that with a little more troublegiven to se cure ample food, the crop might be unlimited. Owing to the insoluble nature of the gluten with which the worm binds the filaments on the cocoon, all attempts to unreel this thread have proved unsuccessful, and this fine strong silk is only dragged off and spun, like so much jute, only into an uneven thread and is always more or less of a dirty colour due to the dirt gathered in this process. In the plains of Assam, a disease seems to affect the worm, and a very large proportion of cocoons are of a bright fawn colour which is hardly noticeable in the cocoons reared in the villages bordering the valley of the Mopili river in the Khassi and Jynteah Hills. This fawn colour is, however, not permanent, and in the spinning and making with other cocoons is not noticeable.

It is difficult to arrive at a correct estimation of the total quantity produced of this kind of silk, as, probably as much as is exported, is consumed in the Province itself to make *pugrees*, *sarees*, *dhoties*, and very serviceable cold weather bed-coverings. Large quantities of these latter are exported to Calcutta, and of late years, the cocoons have been finding favor in the European markets, where more skilful measures have been devised for obtaining an even thread.—(*Indian Agriculturist.*)

NEW THEORY OF DEW.

A correspondent sends the following interesting note:—"A few months ago a new theory was put forward respecting the origin and nature of the moisture found in the morning, on leaves and grass. It had hitherto been held by all naturalists apparently without exception, that this moisture was dew. But a gentleman in Scotland, not known to fame, was not content to accept the current and traditional opinion; and assuming nothing, he investigated the subject *de novo*, with the result that he was able to prove to demonstration that between the dew and the moisture found after a rainless night on vegetation there was an essential difference. He discovered that while dew is but the mere exhalation of the soil, this moisture was an exudation from the vegetation itself. The theory came as a surprise to the scientific world: but the steps of the demonstration were so clearly worked out that the author of the discovery, though not noted as a man of science, was at once brought into public notice. He was held by the highest scientific authorities to have made a distinct discovery in nature. Now, there are some phenomena not mentioned by him which appear undoubtedly to bear out his theory on the subject, and they may be noted at the present time, because they are patent to the observation of us all at this time of the year. Let a tree overhang a white-washed wall or gateway, and in course of time we shall see that the white-wash is covered with green film. On the time-honoured theory that the moisture on leaves was but the exhalation which had risen from the soil during the previous night, it was impossible to account for the colour of this deposit. Mere water would not have produced the phenomenon. The only adequate theory is that the moisture which fell upon the whitewash was chemically a green composition. The theory is further corroborated from the curious fact, equally near at hand to us all, that after a rainless night *mendhi* that was cut on the previous day and is now entirely without green leaves, is dry, while the *mendhi* which is budding and that which has leaves is saturated with moisture. A servant after such a night will, without hesitation, put an article of clothing to air in the sun on *mendhi* so recently cut, though he would deem it the height of folly to place it on green *mendhi* for that purpose. There were two points which first awakened the attention of the discoverer to the subject: the first was, that moisture was found on the under surface of the leaves as well as on the upper; and the second, that moisture was found on the leaves after nights in which no dew had fallen, phenomena for the presence of which the old-world theory provided no satisfactory explanation."—*Indian Agriculturist.*

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STICK MAKING.

Do any Foresters go in for making walking sticks? If so, they may be interested in the few notes sent herewith by one who has made it a hobby for years past in this country. I have spent many a pleasant hour in the forests with a saw and a small axe hunting about for sticks with a good knob and many a scratch and cut have I got in obtaining them. There are many species that suit well for walking sticks and a few for alpenstocks so the latter shall be dealt with first. Perhaps the best all round wood (leaving male bamboo out of the question) is *COTONEASTER BACILLARIS* known as *rauns* in India and *liun* or *ling* in Kashmir; it is an admirable wood and can be worked up in two or three months after cutting if simply left to dry; or it can be made ready at once by heating in a fire; in the latter case, if care be taken, it can be heated so as to leave the bark intact. The wood is close grained and takes a good polish; even the bark if well rubbed down with fine sand-paper shines as if it were varnished. As it is much sought after by natives, one has to hunt far and wide to get a long straight stick, but this adds to the interest of hunting for it. Next to *rauns* I place the *Parrotia Jacquemontiana, killar* in Chamba, *poh* in Kashmir and *posel* in Jammu. This is a strong and very elastic wood but not so stout as *rauns*; it abounds in forests at about 6,000 ft. but it is almost an impossibility to obtain a perfect and straight stick of any length, still, as long as the general direction is straight, a curve or two does not matter. I find that the only plan with this species is to cut it towards the winter and allow it to season during the cold weather with the bark on as it does not stand being dried in the fire and if the bark is taken off while green it cracks; after a month it becomes pliable and can be bent straight without fear of breaking and by the spring it is in fine tough hard condition, always retaining a certain amount of elasticity. I have also made Alpenstocks of wild pear, a good tough wood when seasoned; ash is, of course, a great wood but too heavy for my fancy; plum and even willow will do but none are equal to the two first. When seasoned they should be rubbed down with sand-paper and a good honest spike put on, not the absurd spear

head that one ordinarily sees, so sharp as to be difficult to get out of soft soil, and with a weak neck liable to break off, but a cylinder of steel with a short blunt spike not more than 2 inches long strongly welded on. It should go completely over the stick, nothing being cut away except sufficient to allow of its being fitted, a few taps with a hammer on the butt of the stick will drive it home, but on no account should a nail be driven through the tube of the spike into the wood to secure it, this merely weakens the stick ; the spike will never drop off if properly and tightly fitted at first. I have not mentioned olive wood, but in addition to the almost absolute impossibility of getting a straight stick of sufficient length for an Alpenstock, this species, probably the strongest of all, would, I should say, be far too heavy for the purpose. As regards walking sticks, many kinds of wood are suitable as long as they are put to their legitimate purpose, but if the owner so far forgets himself as to apply them for purposes of castigation to an offending Aryan brother, he will find that very few will stand the strain ! In my opinion, the olive, as found in the Salt Range, and at about 3,000 ft. elevation in the Himalayas, is far and away the best species for a short stick ; it is very hard and strong and takes a beautiful polish from simply sand-papering and rubbing down with a piece of leather. The best plan is to cut the sticks in the winter and put them by with the bark on to season, by March they will be quite dry enough to be worked up and any curves can be taken out by bending while they are drying, this should done every day if possible. Next to olive, *rauns* is the best wood, the sticks are very strong and the knob can be polished till it shines again by simply rubbing, after it has been sand-papered. The best knobs are those cut from roots and the sticks are better when taken up by the roots as in the case of the so-called "ground ash" in England. The wood of the root is infinitely harder than that of a branch and very often there are curious dark markings which are very effective, though in this respect nothing can come up to the dark heartwood of the olive ; but to obtain this in a knob of olive is very difficult, as a very large branch has to be cut and these seldom have straight shoots growing from them : however, they are to be had and are a prize when found. Hawthorn (*ring* in Kashmir) makes a very pretty stick if the bark is kept on, the colour is a rich brown, the sticks are very light and can be got very straight with nice little knobs all the way down but it is not a very strong wood and will not bear beating when green. Parrotia (*Killar*) does not make a good walking stick somehow, at least I do not care for it. The bark is very light coloured and the sticks seem very weak. One thing in its favour is that it is easily carved and a grotesque head can be cut with little trouble ; it takes a fair polish, but is soft to work upon. The barberry (*rasount*) makes a very handsome stick, the young shoots have a very curious streaky bark ; the wood is very tough and has a bright yellow colour, so the bark

should always be left on, I usually burn the head or knob till it is quite black and when rubbed down the mixture of yellow, brown and black in the knob is very effective, especially as the wood shines well when rubbed. Wild pear makes a very good stick, it is very tough and is studded with little knobs, this looks best when burned a rich brown all over. Plum is also very pretty, having a rich coloured bark but the wood is weak; apricot, peach and cherry all make very handsome sticks but are no stronger than plum. I have not yet tried sticks of *Zanthoxylon* but mean to when I find some; fakirs use it for this purpose and it looks a very curious stick with its thorny surface, but it would perhaps be difficult to get good ends. Another excellent wood of the gnarled and rugged kind is the hill "ber," it is never straight and is covered with excrescences, if taken with the root it forms a great stick and can be made up either with or without the bark; it is very tough. There is a species much prized by Kashmiris which they call "gunkash" (?) It is seldom found of any size, and is of shrubby growth, but appears to be very tough: the bark is very thin and papery so it can only be seasoned by time: heat cannot be applied as the bark cracks and blisters at once. Stick collecting possesses many charms for me, as in addition to the pleasure of wandering about the forest hunting for a "real good one" during which time I also have my eyes open for ferns, there is the making up. As soon as the wood is dry enough, I start work with a small saw and cut the knob down to the proper size then to work with a large rasp and smooth down all rough parts. After that a finer rasp and finally a file to take out the marks. Then come an hour or two of hand rubbing with medium and lastly fine sand paper and the stick is ready for use. For ferrules I use old solid drawn express cartridge cases, cutting them to size and filing off the rim, they answer excellently well. As to the shape of the head or knob, that is a matter of taste, most people like a good round lump at the end as it fits well into the hand, but the crutch has its admirers; all this has to be thought of when cutting the stick in the forest and it takes a keen eye to see a good head in a branch while yet uncut, and of course this adds to the pleasure of the pursuit. And now I will cut *my* stick

J. C. McD.

WORKING PLANS.

SIR,

On reading the Review of the Madras and Bombay Annual Forest Reports for 1889-90 in the October number of the Indian Forester, I was forcibly struck with your reference to the preparation of Working Plans in the latter Presidency. As an Officer who has prepared several Plans and has now one to carry out, you will, I trust, permit me to say a few words on this interesting subject.

It is, I believe admitted by every one, that on these plans depends the future of our forests, and thac framing them is about the most important of all our duties. I would then, entrust their preparation only to the best and most practical officers, men who have proved themselves capable administrators, and have held charge of divisions successfully for many years. Hitherto, this all-important work has often been entrusted to the 'faltu,' the young officer recently out from home, who however intelligent he may be, lacks experience and has perhaps never held permanent charge of a division. By such procedure sure disaster is courted in the future. The best man, in my opinion, to prepare a Working Plan, is the divisional officer himself. He knows or ought to know a hundred and one details about his division which would probably escape the notice of a Special Working Plans Officer, who has, may be, never seen the division before, and who may have just been transferred from another province where the forests and conditions are totally different. Let, then, the divisional officer be placed on special duty to prepare the plan, another officer taking his division *pro tem.* If the former be incapable of doing the work, let him be transferred and put a specially selected officer in charge, and let him draw up the plan only after he has held charge of the division for a certain period and has mastered all the details of its working. Once the plan has been prepared let the framer rejoin as divisional officer. He will, one may feel assured, do his best to carry out his own proposals. On the other hand, and this is only human nature, an old experienced divisional officer resents a junior man, who is perhaps a complete stranger to the division, coming for six months laying down the law on this point and on that and tying his and future divisional officers hands for the next ten or twenty years. As soon as the new working plan comes into force, the old divisional officer feels the curb, finds his power restricted in many ways and himself reduced to a mere machine for carrying out the prescriptions of his junior. Then he begins to raise objections. Prescription No. 1 cannot be done as it is perfectly impracticable; it would be much better if prescription No. 3 were altered in such and such a way; as to prescription No. 7 it arranges for working the wrong place, and so forth. In fact first passive and then active resistance is offered and in spite of control books and other ingenious devices, the plan is not carried out as the framer intended. It is thus partially a failure, although in itself it may be all that is good.

Your view that "temporary simple plans for large areas so arranged as to secure the easy collection of the statistics and information regarding capabilities and growth would be best" seems a very sound one. Where is the use of preparing elaborate plans based on a minute calculation of the annual yield, when the rotation has to be fixed in an arbitrary manner. Such plans may, it is true, be framed exactly according to the prescriptions of the

Forest Code, but they should only be regarded as of academical value. To look on them as a practical solution of the problem before us will, I believe, be most injurious, for in reality their foundation is utterly unreliable. Let us then frankly acknowledge that the data we possess are, for the vast majority of our forests, insufficient to admit of the adoption of a proper rotation. Of course, in some cases, it may be feasible to draw up a permanent plan of real value, *e.g.* for sissu plantations in the Punjab, Casuarina and Eucalyptus plantations in Madras, some of the deodar and chir forests in Northern India. Otherwise, let only Preliminary Working Plans be prepared for a term of ten or twenty years at the most. Let the framer keep their preliminary nature always before him and remember that one of their most important objects is to lead up to a more permanent plan hereafter; with this idea always in view, the past history of the forest should be carefully given, together with all observations which have been made concerning the growth of the component species. These observations may, it is true, not be utilised in the preliminary plan for calculating the possibility, but they will prove of immense service hereafter when the more permanent plan comes to be made. Such a preliminary plan is, as was remarked to me the other day, not a working plan at all, in the real sense of the term, but only a plan of operations for a definite number of years. This seems exactly to represent the state of the case and such a plan if properly drawn up, will be of the greatest service, and will not be such a leap in the dark as a technically correct plan based on a rotation fixed more or less by guesswork. Such a preliminary plan for, say, ten years, can provide for plenty of work quite apart from fixing the rotation. It can organise a regular system, say, of improvement fellings, of climber cutting, clearings and girdlings; it can put fire protection on a proper footing, can prescribe the planting up of all suitable blanks, it can prescribe roads which will effectually open out the forests and it can provide for suitable accomodation for all classes of forest officers; it can divide the forest into compartments, blocks and tentative working circles, always keeping in view the revision which will take place at the end of the ten years, and making the circles elastic wherever possible. It will, of course, provide for the proper collection of statistics regarding the rates of growth of the chief species. Whatever is laid down, however, should be prescribed with a fair amount of minuteness. One of my chief difficulties with the plan I have to carry out, is that it does not particularise enough; and, in consequence, a kind of supplement to it will have to be prepared. Sweeping generalisations are all very well in reviews, being an easy form of criticism, but the officer who has to carry out a plan wants precise and definite instructions, while at the same time the plan ought to be elastic: and it seems desirable that Conservators should be permitted to carry out improvements other

than those prescribed. The framer may have overlooked some obvious improvements and new circumstances calling for unforseen works are almost certain to arise within the decennary. It would seem best, therefore, to allow them more latitude than they at present enjoy in areas under working plans.

It is to be deplored that working plans are not more widely circulated. Personally, I should like to read every plan as it comes out, whether it be good, bad or indifferent. I believe such a course would be of great service to working plans officers in particular, as they could shift the chaff from the wheat, obtaining valuable hints for their own work. The working plan for Thana, to take an instance, with its 300 odd working circles could not, I am sure, but fail to be instructive.

The Indian Forester might also give us a brief summary of these plans as they appear, together with a short critical review.

TAU THA.

MADAGASCAR TEAK AND MALABAR MAHOGANY.

Can any of our readers tell us about these? The following extract from the Report of a great sale held in October at the 'Baltic' sale rooms, chiefly of Mahogany and other cabinet woods, shews that an attempt was made to sell these woods in London but unsuccessfully.

" Madagascar teak, *ex Linda*, was duly offered as a substitute 'for East India teak, to which it was said to be similar and by 'some even better. The broker was most anxious to sell, and 'offered it at low and tempting prices, but there was no response 'and he then said he should be happy to treat for it in private— 'the Hazina wood, *ex* same ship, was put in at 6d., and with 'difficulty forced up to 11d. without reserve. Two lots of furni- 'ture wood were sold at 1d. and 1½d. respectively, and the six 'lots of Malabar mahogany, *ex Peshawur*, were passed without 'a bid."

We remember once seeing the Prospectus of a Madagascar company in which it was gravely set forth that the forests were full of " teak, mahogany, ebony and other valuable timber." The promoters presumably wished it to be thought that the teak was the same tree as the East Indian and that the mahogany was undoubtedly the proper thing.

At the same sale, we see that Padouk sold at £2-10 per ton which is only 1d. per cubic foot but that East Indian Ebony fetched 3s. per cubic foot and East India Walnut 1s. 7d. Both were shipped from Bombay. What forests did the Walnut come from? Can any one tell us?

CULTIVATION OF TEAK IN JAVA.

The following abstract, which is taken from the Colonial Report for the year 1890, shows the area of the plantations of Djati (*Tectona Grandis, Linn. fil.*) in the different provinces of Java as well as the area of natural teak forest in each province.

The abstract further shows how many acres have been planted during the last year.

A total area of 5,098 acres was planted in the rainy season of 1888-89 (1st June 1888 to 1st June 1889). The total cost of this was £5,237 or a little more than £1 per acre. The new plantations have been surveyed and mapped. All these plantations were voluntarily carried out by the natives under the superintendence of a native forest officer at a rate varying from 10s. to £1 per acre successfully stocked. Last year's plantations were carried out according to the so-called Burmese method of planting, as this method has been proved to give the best results here.

K.

TABLE SHOWING TOTAL TEAK-PRODUCING AREAS IN JAVA IN 1889.

Name of Province in Java.	Natural forests.	Teak Plantations.					Remarks.
		In June 1865.	From 1st July 1865 to 1st July 1880.	From 1st July 1880 to 1st July 1888.	From 1st July 1888 to 1st July 1889.	Total.	
		Acres.	Acres.	Acres.	Acres.	Acres.	
Bantam	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	The mark + indicates that the area is not precisely known.
Preanger	31,503	218	824	748	*Nil.*	1,190	
Krawang	3,487	735	*Nil.*	489	76	1,300	
Cheribon	31,904	*Nil.*	*Nil.*	459	50	509	
Tegal	11,487	1,122	1,046	1,799	200	4,167	
Pekalongan ...	4,085	1,200	1,302	1,692	446	4,640	
Semarang ...	184,751	10,284	1,185	5,464	1,245	18,178	(1) measured acres.
Japara	39,821	+	+	+	146	+	
Rembang	554,316	8,795	7,722	5,381	1,091	22,989	
Soerbaija	110,234	97	1,698	2,628	87	4,510	
Pasoeroean ...	18,837	*Nil.*	1,461	917	152	2,530	
Probolinggo ...	+	+	+	+	322	+	
Besocki	+	+	+	+	142	+	
Banjoemas ...	138	1,508	947	913	740	4,108	
Bagelen	2,294	1,525	344	1,834	807	4,510	
Kedoe	Nil.	1,023	+	156	*Nil.*	1,179	
Djokdjakarta ...	+	+	+	+	*Nil.*	+	
Soerakarta ...	35,384	+	+	865	146	1,011	
Madisen	226,584	781	1,213	957	150	3,101	
Kediri	52,342	6,880	688	2,350	116	10,034	
Total ...	1,455,000	+	+	+	5,916 (1)	+	

K.

The above paper was was received in German from our correspondent and we are indebted to Mr. C. G. Rogers for the translation and for kindly transforming the figures into English standards; a hectare has been taken equal to 2·47 acres and a florin or gulden equivalent to 1·8s.

Hon. Ed.

FOREST FLORA OF BRITISH BALUCHISTAN.

We are indebted to Mr. J. H. Lace, F. L. S., of the Punjab Forest Department, for a copy of the paper by himself and Mr. W. B. Hemsley, F. R. S., of Kew, on the vegetation of British Baluchistan which was published in volume XXVIII of the *Transactions of the Linnean Society*. From his paper we extract the following account of the vegetation of the Forests of the country, which we think will prove of interest to our readers.

FORESTS.

The juniper, *Juniperus macropoda*, is the only tree which forms forests of any extent, the best of them situated some sixty miles east of Quetta, in the neighbourhood of Ziarat, and extending over more than 200 square miles of country. There also remain a few square miles of juniper on the Zarghan range but in this direction a great deal has been destroyed to keep Quetta supplied with fuel for the troops and public works. The juniper usually exists in open forest. Trees with clean boles are very rare, and they are generally branched from the base, the lowest branches being often burried in leaf detritus near the trunk, and their extreme ends taking an upward turn, give them the appearance of young trees surrounding the old one. The trees often take the most fantastic shapes, their branches being gnarled and twisted in every direction, and when their main shoots have been cut off many feet from the ground, which is often the case, they assume a candelabra shape.

The growth of the juniper is very slow, yet it attains twenty feet in girth and occasionally seventy feet in heigh. Although it reproduces itself from seed, very few of the seedlings survive, owing chiefly to climatic conditions. The wood is light, has little strength, and burns quickly, and is employed extensively in building, principally for rafters, but it is even more extensively used for fuel. The bark is of immense thickness at the base of old trees and is taken off in long pliant strips by the Pathans, who use it for roofing their huts. A kind of liquid called "Doshah" is prepared from the fruit, and the fruit is also employed in curing shins.

Pistacia mutica var. *cabulica* is common on some of the arid, stony hills and in dry watercourses, from 4,000 to 7,500 feet, for instance at Gwal Dozan in the Bolan Pass, at the base of the Chihiltán and Mashalak ranges, on the Khwája Amran, near Anambar, and in other localities. At the last named place it has grown up in the midst of large bushes or small trees of Acacia *modesta*, the latter affording it protection from being grazed by camels, sheep, and goats, and this may well be called the meeting point of the typical trees of the low hills of Baluchistan and the

Punjab. This Pistachio-tree never forms forests, but is usually gregarious, or scattered at intervals over the ground, the very best portions being somewhat like a very open orchard. It attains 20-25 feet in height and 6-10 feet in girt; and the short and clean bole is surmounted by a large, ample crown, the outline of which is almost semicircular in a well grown tree. The wood is very hard, dark, and finely grained, and is a most excellent firewood, in fact the best in the country. The fruit, called "Shnee," only abundant every third year is much prized by the people. This species is easily distinguished from *P. Khinjak*, which usually occurs as a shrub in clefts of limestone rocks between 5,000 and 6 000 feet, or near Hurnai as a tree 20 feet high, much branched from the base, by its leaves and its bark. The bark of *P. Khinjak* is light grey in colour on the exterior and reddish brown inside, and is smooth and exfoliating, whereas that of *Pistacia mutica* var. *cabulica* is dark brown with longitudinal fissures. The two species are distinguished by the natives, who call *P. Khinjak* "Ushgai" or "Bazgai," and *Pistacia mutica* var. *cabulica* "Gwan" (Baluchi), "Khanjak" (Peshin) "Badwan" (Hurnai). These native names are worth recording, because evidently *P. Khinjak* received its name from "Khanjak," though in Boissier's 'Flora Orientalis' the description of that species correponds to what the people call "Ushgai," and that of *P. cabulica* with the real "Khanjak."

The common olive is another small gregarious tree scattered over larger areas than the Pistachio, and usually at a lower altitude, it range being between 2,500 and 6,500 feet. It is abundant in the ravines and sheltered situations on the south sides of the Khalipat range, on the cliffs of the Wám and Mehráb rifts, and it is said that there are some very fine groves of it in the Zhob valley.

Between the Wám rift and Hurnai, at 3,500 feet, a broad, stony, usually dry watercourse is covered with a curious mixture of tree-growth, forming a fairly thick jungle. The chief element is *Dalbergia Sissoo*, which attains some size, and this is mixed with *Tecoma undulata*, *Olea*, and *Pistacia*; the principal underwoods being *Dodonæa viscosa*, *Grewia oppositifolia*, *Periploca aphylla*, *Gymnosporia montana*, *Rhamnus persicus*, *Zizyphus oxyphylla*, and *Sageretia Brandrethiana*.

In the Thal-Chotiali district, along the banks of the Narechi river and in the Pujjha valley, *Populus euphratica* forms a fringe, with a belt of *Tamarix articulata* on each side, forming forest in places.

A CONVENIENT FORMULA FOR SURVEYORS.

It is desirable, when a closed traverse is made with a compass, to test the accuracy of the bearings taken, by what is known among Surveyors as "putting up." This is simply an application of Euclid I. 32, Cor. 1, which proves that all the interior angles of any rectilineal figure, together with four right angles, are equal to twice as many right angles as the figure has sides. To be able to apply this test, one must first find out the interior angles from the bearings.

Also when a survey has been plotted, it can be very easily checked with only a rectangalar protractor, if the interior angles are known.

The interior angles can be worked out geometrically, but the process is rather puzzling, and when a large number of them are required, becomes extremely tedious. Hence the utility of a general formula by means of which the angles can be worked out *seriatim* almost mechanically, and with a little practice, even mentally.

As I have not seen such a formula in any of the well known books on Surveying, I give one below, trusting it will be useful to those, who, like myself, have often to do survey works in the forest.

FORMULA.—From the bearing of the second line subtract that of the first. If the difference is between 180 degrees, and —180 degrees, add 180 degrees to it; if it is less than—180 degree, add 540 degrees; but if greater than 180 degrees subtract 180 degrees from it.

It will be observed that the angle thus obtained will be the angle towards the left of the surveyor. As it is the rule in traverses to go round the area to be surveyed anti-clockwise, this left hand angle is almost always the interior angle required. Should, however, a survey be made with the area to the right, the only alteration necessary in the rule would be "From the bearing of the *first* line subtract that of the *second*." The rest will hold good in both cases.

DEHRA DUN
Sept. 22nd, 1891.

UPENDRANATH KANJI LAL.

VANILLA IN MERGUI.

The Burma Gazette of October 3rd 1891 has an account of the work done in 1890-91 in the experimental plantation at Mergui, which after giving the results of the years' work in the growth of coffee, cocoa and tea finishes up with a 'Memorandum on the curing of Vanilla' by Mr. C. Ingram, Sub-Assistant Conservator of Forests, South Tenasserim Division, which we have read with much interest, and reprodnce, as it may be useful to Forest Officers in other places which, like the Divisions on the Malabar coast, are capable of growing that most valuable plant.

Coffee seems to do well, but to suffer like the bushes in Ceylon and on the Nilgiris from the ravages of *Hemileia vastatrix.* Apparently, all the plants are of the Liberian species, and we agree with Mr. Ingram that a plantation of 2 acres is not large enough to settle the question of whether or not coffee will pay in Mergui. Pepper, we see, is also cultivated and we are glad to remark that the cultivation is extending, which is a good thing, as we believe pepper to be an exceedingly paying crop and one which has been somewhat neglected. It is not much use inciting people to make tea and coffee estates in Mergui, considering that both products are suffering from over production, but the cases of cocoa and pepper and vanilla are different, while we hope that if such a useful and interesting experimental garden is kept up and extended, some attention will be paid to gamboge and gutta-pecha, both of which are Forest trees and worthy of the best attention of the Department.

MEMORANDUM ON THE CURING OF THE VANILLA OF THE MERGUI GARDEN,

AUGUST 1890-JANUARY 1891.

I.—The different methods of curing Vanilla in vogue.

Descriptions were compiled of the methods of curing vanilla as followed in Mexico, Guiana, Peru, and the Island of Reunion, and it was necessary to select one of them to be followed.

I.—In *Mexico* the pods are collected and placed in heaps in the shade from sun and rain, and left for a few days. (This is necessary, as I found that if the pods were plucked and put in the sun at once they always split down the sutures). Then—

(*a*) If the weather is warm and clear, they are spread out on a wollen blanket and exposed to the direct rays of the sun. At midday the blanket is folded round the pods and the bundle is left in the sun for the remainder of the day. In the evening it is enclosed

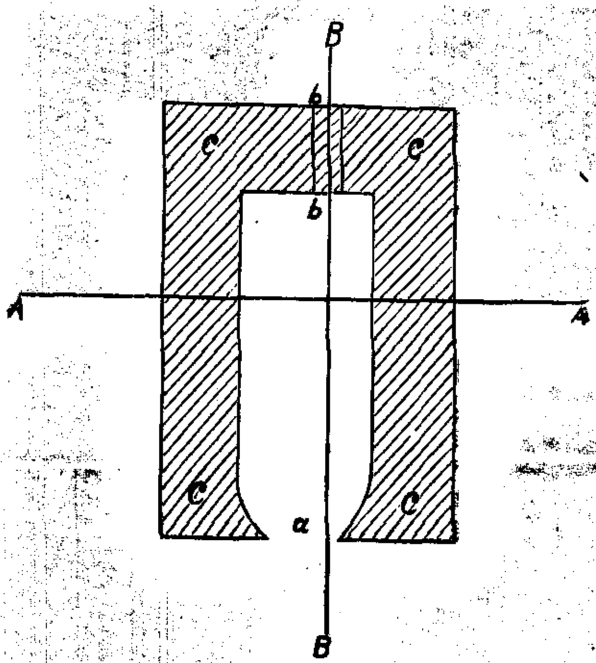

FIGURE 1.

Ground Plan of Furnace.

a *Mouth of furnace.*
b b *Chimney.*
c c c c *Wall of furnace.*

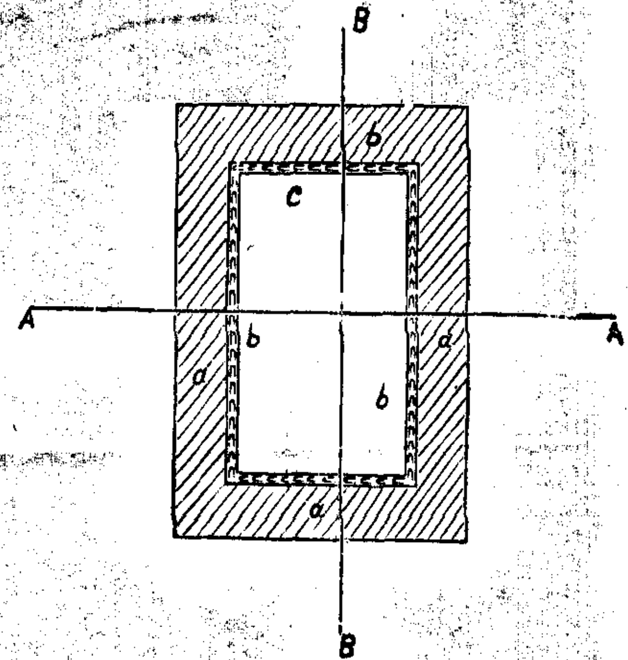

FIGURE 2.

Plan of Heating Oven.

a *Walls of oven.*
b *Wooden box.*
c *Space enclosed by box, into which vanilla is placed.*

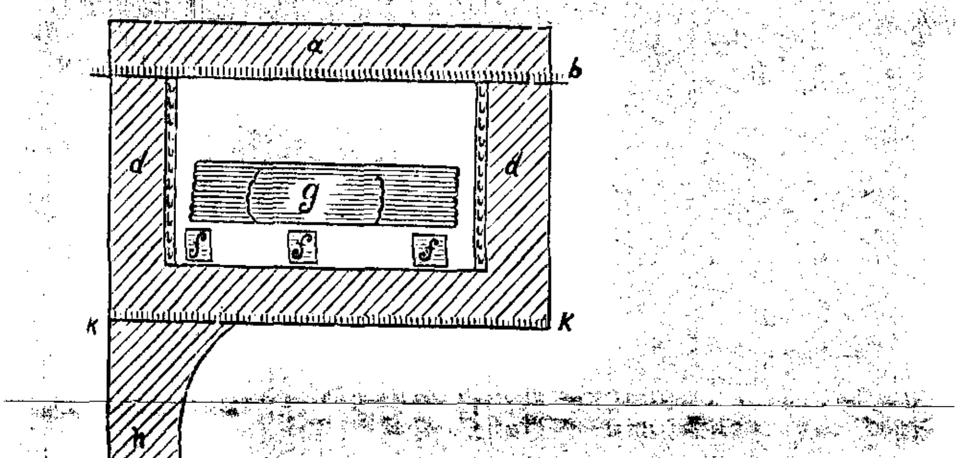

FIGURE 3.

Section on A A.

a *Moveable lid of oven.*
b *Iron grating supporting it.*
c *Plaster to make oven air-tight.*
d *Walls of oven.*
e *Wooden box.*
f *Bent iron hoops.*
g *Bundle of vanilla.*
h *Walls of furnace.*
k *Iron grating supporting bottom of oven.*

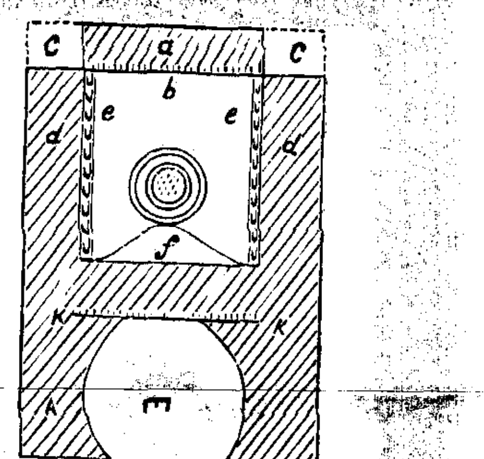

FIGURE 4.

Section on B B.

b *Chimney.*
e *Furnace (fire-place).*

C. INGRAM,

Assistant Conservator of Forests.

SCALE 1/16.

in a light wooden box to "sweat" all night. Next day the same treatment is followed and the pods, after exposure to the sun, acquire a dark coffee-colour,—the shade deeper in proportion to the sweating process.

(*b*) If the weather is cloudy and rainy, the vanilla is collected into bundles, a number of which is packed into a small bale. This is first wrapped with a woollen cloth, then with banana leaves, and finally with stout matting, which is firmly bound and sprinkled with water; an oven is then heated to 140°F. (60°C.) and the bales containing the larger beans are put into it. When the temperature has fallen to 113°F. (45°C.) the smaller beans are introduced and the oven is tightly closed. Twenty-four hours afterwards the smaller beans are taken out and 12 hours later the larger ones. The vanilla has then acquired a fine maroon colour.

The drying operation then commences. The beans are spread on matting and exposed to the sun for nearly two months. When the drying is nearly complete it is finished in the shade, and the beans are tied up into small bundles for sale.

II.—In *Guiana* the pods are placed in hot ashes till they begin to shrivel, then wiped and rubbed with salad oil, tied up at their lower ends, and hung up to dry in the open air.

III.—In *Peru* the pods are first dipped in boiling water, then tied up at their ends and hung up in the open air. After 20 days the pods are rubbed with castor oil and a few days later are pressed into bundles

IV.—In the Island of *Réunion* the ripe fruit are sorted according to length and scalded. The long ones are dipped into water 194°F. (9°C.) for ten seconds, the medium ones for one miuute or longer. They are then exposed to the sun between woollen blankets until they acquire a maroon colour, which happens in about six or eight days. The pods are then spread on hurdles and placed in garrets to dry gradually; when the pods are sufficiently dry to allow them to be twisted round the fingers the process called "smoothing" commences. This requires great care as every bean must be passed through the fingers from time to time so as to spread the oil which exudes on the whole length of the bean as the fermentation proceeds. On this treatment the lustre and suppleness of the vanilla depend. The beans are also turned frequently to ensure their drying equally on both sides. In a month the pods are dry and are then sorted out according to their lengths—

(1) *Fine vanilla*, from 8 inches to 11 inches long, glossy dark-brown and unctuous. Some covered with fine frost like crystals known as *giore*.

(2) *Woody vanilla*, from 6 inches to 8 inches long,

lighter in colour, not glossy, presenting grey spots on the surface, and having very little *giore.*

(3) *Vanilla*, consisting of two varieties, both short—

(i) obtained from ripe fruit and covered with white crystalline efflorescence ;

(ii) obtained from unripe fruit and owe their colour to contact with those of better quality.

Of the four methods described above, I determined to select that followed in Mexico, the vanilla from Mexico being considered the best in the market.

2.—*Heating oven used.*

In the Mexican method of curing, it will be seen that there are two processes: one for fine weather and one for cloudy and and rainy weather. The first pods were plucked on the 27th August, when the weather was very showery. This entailed my devising an oven which would retain heat for about 48 hours. I made one of well-wrought clayey earth which, as it is interesting, I describe. The apparatus consisted of an oven with a furnace below.

The furnace measured 3 feet by 2 feet (outside) with walls 6 inches thick and 12 inches high. Opposite the opening of the furnace a round hole was made in the wall, and a bamboo, open at both ends, was inserted as a chimney (figure 1). On the top of the furnace an iron grating was placed (Figures 3 and 4—*k*, *k*). On this mud to a height of 4 inches was plastered. This formed the foundation to the heating oven. An ordinary kerosine-oil box with its top and bottom sides knocked out was placed on this foundation, and mud was plastered to a thickness of 4 inches all round the four sides of the box (Figure 2, *a*, *b*, and Figures 3 and 4, *d d* and *e e*). On the top of the oven another iron grating was placed, on which mud was plastered to a height of 4 inches also. The length of this last mud plaster was the total length of the oven, while the width was the width of the wooden box only. This formed the cover of the box and was moveable. When the oven was heated up to the required heat, plaster was laid on at *c c* (Figure 3), this made the oven air tight. The object of having the walls of the oven 4 inches thick always was to retain the heat inside for a long time. At the bottom of the oven three pieces of bent hoop-iron were placed as a support for the vanilla and in order to keep it as much as possible in the centre away from the hot bottom,

When this apparatus was finished it took 36 hours to dry with a strong fire in the furnace; and when once dry it always took six hours to get the heat in the oven up to 140°F. But it retained the heat admirably, being warm even after 36 hours from the time of plastering the cover air-tight. Although it answered its purpose (the heating of only a couple of hundred pods) admirably, it was at the best a very temporary and *katcha* affair. Where a large

amount of pods required sweating the apparatus would of course be of brick or any other *pucca* material; and a swinging door on one side for the oven would be perferable to having a moveable lid, as it would then be possible to have a fire on the top of the oven as well, equalizing the temperature over all parts of the oven.

3.—*The process of curing.*

One hundred and thirty-five pods were plucked on the 28th August and put in the shade. They were sorted into two sizes, large and small. Each size was made up into a bundle as follows:—

> Pods first wrapped in thick woollen cloth to a thickness of 2½ inches all over, then wrapped in plaintain leaves and then in stout palmyra leaf-matting 6-fold, the whole tied tightly with cane and sprinkled with water. The oven being previously heated to the required temperature, the bundles were put into it and the cover plastered so as to make it air-tight. The vanilla bundles were put in on the morning of the 30th the bundles of smaller pods taken out on the morning of the 31st, and the large ones in the evening.

The process was a decided success as the pods were of a fine maroon colour and smelt very strongly of vanilla. One hundred and eighteen pods were subsequently treated in the same way with a like success. The great difficulty now was to dry them. The first few days after the heating process the weather though showery was now and then clear, and the pods obtained a sunning for about an hour daily. This, if it did nothing else, prevented the formation of mildew on them. But from the 6th September to the beginning of October the weather was peristently rainy; and although I did my best to keep the pods dry by placing them over a dry charcoal fire, I was not able to prevent the formation of mildew on them. The immediate effect of the mildew was to give the pods the peculiar rancid smell of rotting succulent vegetables, the flavour was lost, and subsequently, when the weather changed and there were clear days, the mildewed parts on being sunned became quickly dry, hard, and brittle, and the pod instead of becoming gradually of a glossy, coffee colour, became of a dry, brown one, and was almost scentless. If mildew can be prevented from forming, I have no hesitation in saying that the curing of the vanilla next year will be a decided success. But this is a difficulty not easily overcome: the pods ripen in August-September and the curing must of necessity take place when the rains are heaviest and when the air is saturated with moisture. In order to obviate this as much as possible, it will be advisable to defer the plucking and make it as late as possible, great care being taken to prevent the pods from cracking while drying.

V. NOTES, QUERIES AND EXTRACTS.

THE UNITED STATES GOVERNMENT TIMBER TESTS.

The Division of Forestry of the United States Department of Agriculture has commenced a series of examinations and tests of American timber, which far exceeds in magnitude and in scientific thoroughness anything ever before undertaken in this direction. According to the *American Architect* there are three departments of the work:—

I.—The Selection of the Timber.

The trees to be examined and tested are first selected by a competent botanist and forester from five or more localities, four large trees of a given species from each place, these sites differing from each other as much as possible in climate and soil conditions. These trees are cut up into logs from 6 to 18 ft. in length, with intervening disks 8 in. long. A complete record is kept of the botanical names, conditions of growth, time of cutting, age of tree, size, height, &c., and the north and south sides of each log and disc are marked on them, together with the number of tree and of the log. The logs are shipped to St. Louis and discs are sent to Ann Arbor, Mich. Discs are also cut from younger trees and sent to Ann Arbor.

II.—The Physical Tests.

The physical tests are carried out at the Washington University Testing Laboratory, St. Louis, under the direction of the writer. The logs are first sawed into appropriate sizes at an ordinary saw-mill. Each log is marked off on its end by a stencil plate in such a way as to obtain a series of 4 in. by 4 in. sticks in a north and south zone, and as large a stick alongside as the log will allow, up to 8 in. by 16 in. Each stick is marked with a die with the number of the tree, the number of the log in that tree and the number of the stick in the log, the numbers being on the lower end of the log and reading upright when the north side is upward. In this way each stick carries a legend, which cannot be effaced, which fully identifies it. A series of stamps,

corresponding to the stencils, is used to show, in the note book, the way in which the log was cut and marked.

After sawing, the sticks are carefully stacked under shelter to await the tests. In the course of, from one to three months after sawing, one end (half) of each 4 in. by 4 in. stick is tested, and also some of the large sticks. The regular tests are as follows :—

1. *The Cross-Bending or Beam Test.*—In this case the load is always put on at the same rate, so as to produce an increase in the deflection of ½ in. per minute, and continued uniformly up to rupture. The simultaneous loads and deflections are read off about eight or ten times during the test, the scale beams always being kept balanced and the deflection read off by means of a micrometer screw on the small beams, and from a thread over a paper scale on the large beams. The 4 in. by 4 in. sticks are tested in lengths of 60 in. between knife edges, all bearing-surfaces being protected by iron plates. The machine used was specially designed for this kind of work and was described in the *Engineering News* of September 14th, 1889.

The large beams are broken on a machine of an original design, consisting of a hydraulic cylinder, plunger, screws, and cross-head, made by Riehlé Brothers, and similar to the parts used in their 100,000 lbs. testing machines. The base or beam part of the machine consists of two long leaf-yellow pine sticks, 6 in. by 20 in. by 24 ft. long, both being clear, straight, grained wood. Between these there is a steel flitch plate ¾ in. by 18 in. by 20 ft. long, all bolted together through their neutral axes.

The weighing is done in a standard 100,000 ℔. Riehlé machine near by, both being connected up with the same pump, and the weighing machine being blocked. The plungers of the two machines are of the same size, and therefore, except for the difference in the frictional resistances of their plunger packings, they should show the same load for the same unit pressure in the pump. They have the same kind of leather cut packing, and when tested by nests of calibrating springs they show equal loads for equal deflections of springs. These calibrating springs were first tested on the Emery machine at the Watertown Arsenal, and hence both these machines are now standardised with that one. Since this large beam machine will place a load of 100,000 lbs. on a beam 24 ft. long, there has probably never been a wooden beam or a rolled iron or steel beam which could not be broken on this machine if taken in a length from 20 to 24 ft. This is also the only beam machine of large capacity with which the writer is acquainted. There are following nuts placed on the power screws, by means of which any given deflection can be held, and in this way time tests can be made on large beams.

From the plotted results, loads and deflections, the modulus of elasticity and the total resistence of the timber up to the point

of maximum loading in inch-pounds per cubic inch of timber are computed in addition to the strength.

2. *The Percentage of Moisture.*—After breaking the beam, it is next bored through 18 in. from each end, and one-third the width of the stick from one side, and the borings used for determining the percentage of moisture Prof. Bauschinger has shown that when the moisture in a stick has fallen below 20 per cent., and especially when below 15 per cent., the strength increases very rapidly as the moisture diminishes.

3. *Specific Gravity and Width of Annual Rings.*—The ends of the broken beam are now cut off, and used for making the other tests named below. One of these is weighed and measured and the specific gravity determined. The number of annual rings is also counted in a radial direction across the stick, and the average number per inch is recorded.

4. *Crushing Endwise.*—From each 4 in. by 4 in. stick, there is cut a section 8 in. long, and from each large beam there is cut a column 40 in. long and 4 in. by 4 in. in cross-section, and these are tested in compression endwise until the fibres are crushed down and the maximum load passed.

5. *Crushing across the Grain.*—From each beam there is taken a section and crushed across the grain on an area 4 in. by 4 in. The maximum load is found to occur when the compression is about 3 per cent. of the height, and hence this amount of distortion is taken as the standard and the compression load found at this limit, which is also considered a reasonable limit in practice.

6. *Tensile Tests.*—The tensile strength is found by taking a piece 1 and $1\frac{1}{2}$ in. by $2\frac{1}{2}$ in. by 15 in. long, and cutting it down on circular curves to $\frac{3}{8}$ in. by $2\frac{1}{2}$ in. at the centre, and then pulling it on the 100,000 lbs. Riehlé machine. It is held between the ordinary flat wedge-shaped grips. It is very difficult to break timber in tension, but after trying various shapes and methods of holding, the above was found most simple and entirely satisfactory.

7. *Shearing Test.*—The shearing strength is found by pulling out ends of the slotted holes. A piece $2\frac{1}{2}$ in. square is slotted 1 in. from each end, with a hole $\frac{3}{4}$ in. by 1 in. Steel pins are inserted in these and pulled by means of a suitable stirrup. The two holes are cut at right angles to each other and both are pulled out, thus getting the shearing strength both ways with reference to the direction of the annual rings. The stick is kept from spreading, or splitting out, by means of head clamps which are put on outside the slotted holes and screwed up to a bearing before the test begins, the initial pressure being only a few pounds.

In all the above tests the direction of the rings is sketched in, and records show also its exact position in the log and in the

tree, so that all known pertinent facts are recorded. It is only in this way that the laws governing the strength of timber can be found. The reserved sticks will be tested some two years or more later after seasoning, which will be under shelter

There will probably be as many as 2,000 tests made on each of the more important species of timber, and when these are properly collected and discussed it is thought that little will remain undiscovered in regard to the conditions governing the strength of sound timber of all the common varieties. The work has begun with the Southern yellow pines and oaks, six car loads of logs having been received and sawed to date. Since one large stick is cut from each log, and at least two small ones, the relative unit strength of large and small timbers will be determined. The effects of knots, windshakes, seasoning cracks, &c., are also sure to be determined.

Tests of Old Timbers.

It is often very desirable to know the strength of old bridge timbers, which, though apparently sound, are more or less cracked along their neutral axes, and have been in service many years. If railroad and bridge engineers choose to send in such timbers full size, just as they have been used in the structure, they will be tested promply and at a very small cost. A few tests of this kind would go a long way towards educating the judgment of a chief or of any inspecting engineer who may be charged with the responsibility of deciding when to replace an old structure with a new one.

III.—The Microscopic and Structural Examinations.

The specimen discs sent to Ann Arbor, Mich., are examined and studied by competent botanists of the University of Michigan and photographs taken of the structural formation. The article is, however, for the information of engineers and architects rather than of botanists, and hence is mostly taken up with a description of the physical tests. This work will run for many years, if sufficiently supported by public opinion, on which all State work really rests. If it is continued in the same scale of thoroughness with which it is begun, it is impossible to overestimate its value, both to timber users and to timber growers, for one of the ultimate purposes is to learn the conditions most favourable to the profitable growth of the more valuable kinds of timber. Neither are the results of these studies of most immediate use to engineers and architects, but the carriage, waggon, and implement makers, car builders, furniture manufacturers, and the public generally, are equally interested, since it is only the needs of the public which all these are trying to serve.—*Timber Trades Journal. 19th September 1891.*

EXPERIMENTS IN FORESTRY.

Although the large quantity of timber still growing on Canadian soil tends to check interest in forest preservation and extension, the Federal Government has recognized the need of such efforts, and has for some years been testing many varieties of tree life at its experimental farms. At the Central Farm, near Ottawa, the seeds of Rocky Mountain and European conifers were liberally sown. This year 175,000 seedlings were transplanted from these beds, to be distributed later on to the branch farms and private experimenters, who will send in careful returns of progress. This year, too, the Government has distributed 100,000 forest-tree seedlings amongs 1,000 applicants in the North-West, with instructions for planting and future treatment. Twenty-five "gardens" along the main line of the Canadian Pacific Railway have also been supplied from the experimental farms. The urgent need of forestry, even in the old provinces, not long ago covered with trees, is illustrated by Mr. J. C Chapais, an authority on such subjects. "I know whole regions," he says, "which were cleared by settlers who had to desert the land soon after because it was worth nothing. Such districts would have been as many inexhaustible wood-reserves for future generations, who, for an almost endless period of time, would find on them all the wood they want. To-day these same districts are quite useless in every respect."—*Times.*

GUTTA PERCHA.

The price of gutta percha has nearly doubled in two years and now rules at $1-30 per pound. This remarkable advance in the price of the article is attibuted to two causes—the large quantities required in the manufacture of electric and other modern devices and the reckless destruction of the trees from which the gum is obtained. Gutta is the Malayan term for gum and percha is the name of the tree from which it is obtained; therefore the name may be translated, gum of the percha tree. This gum or sap is not obtained by merely tapping the trees, as is done by the gatherers of crude rubber along the Amazon and its tributaries; but the Malays and natives of Borneo, who collect gutta purcha, fell each tree from which gum is to be extracted, and thus the destruction of the trees and consequent scarcity of the product is explained. From 1854 to 1875 90,000 piculs, weighing 133⅓ pounds each, of gutta percha, were exported from Sarawak alone, and this meant the death of 3,000,000 trees. As no trees are planted, the only thing that has saved this species of plant from annihilation is that it does not produce the gum in paying quantities until it is twenty-five to thirty years old.

The method pursued in felling the trees is as follows: A staging is erected from fourteen to sixteen feet high, which enables the workmen to cut the trees just above the buttresses or banees as they are called. Thetools used in felling are either "bliongs" or "parangs"; a *bliong* is a kind of axe used by the Malays in felling, building, and the like. The blade is of a chisel-like form and the tang is secured at right angles to a handle by means of a lashing of rattan or cane. The *parang* looks more like a sword bayonet, and in the hands of a Malay is said to be a box of tools in itself, as with it he can cut up his food, fell a tree, build a house or defend himself. After the tree is cut down, some natives beat the bark with mallets to accelerate the flow of the sap, which usually runs slowly, changing color meanwhile. It concretes rapidly.

The sap is boiled either with water, lime juice, or cocoanut oil; and it is generally run into moulds which sometimes produce forms of the hardened material resembling various animals in shape.

The gutta percha tree, the vernacular name of which is *laban*, also bears a fruit about an inch long, ovoid in shape, which is eaten by the natives. In Siak, Sumatra, a vegetable butter is prepared from the seeds of this fruit. The trees attain to a height of from 60 to 80 feet, with a diameter of from 2 to 4 feet. The wood is soft, fibrous, spongy, of a pale color, marked with black lines, these being the reservoirs of the gutta percha. The yield of a well-grown tree of the best variety is from 2 to 3 pounds of gutta percha, such a tree being about 30 years old, 30 to 40 feet high, and 1½ to 3 feet in circumference.

Gutta percha is used in a multitude of different ways. It has been found to be the best non-conductor of electricity and most perfect insulator that has yet been discovered. A wholesale dealer in the article recently stated that scarcely a week passes but some one calls upon him claiming to have found a substitute for gutta percha, but none of the substitutes so far offered has been able to meet the requirements. No other substance has been found so efficient for submarine cables; and according to a statement recently published in the New York *Sun*, the Atlantic cable laid in 1857 is still preserved by its gutta percha covering.

This article retains its form at a temperature below 115° F. It is insoluble in water, even in salt water, and it is also insoluble in alkaline solutions and various acids and is, therefore, made into vessels to contain these substances. By mixing bisulphide of carbon with gutta percha, a liquid cement is produced which is employed in putting patches upon shoes, thus dispensing with sewing and securing a neater appearance on the shoe. The same cement is also used in repairing rabbit skins. These skins are weak and are easily torn; but by backing them with this cement they are made tougher, and are also sold in some cases by unscrupulous dealers for squirrel skins. Another use to which gutta percha has been put is placing it round the bottoms of pantaloons to protect them from wear. It has been made so thin that a yard of it weighed only 7 to 8 pounds. A piece of this was placed around the bottom of the garment, then an inch of cloth was turned in the top of the gutta percha, a hot iron was passed over it, which rendered it secure, thus saving the expense of sewing to the manufacturer.

Since gutta percha has advanced so greatly in price, it has been found impracticable to use it for this and many other purposes; in fact it has been stated that a large engineering firm in the United States proposed to enter upon the manufacture of submarine cables on an extensive scale, but were unable to carry out their purpose, on account of the scarcity and the difficulty of obtaining gutta percha.

Efforts have been made to check the destruction of this most useful tree by substituting tapping for felling, but the greed of the natives is so great that they adhere to the latter method, because it gives them more of the sap for immediate marketing, being regardless of the fact that the trees are being exterminated. The only remedy for the great scarcity of the article seems to be the cultivation of the tree, and measures of this kind will have to be adopted if gutta percha, which seems to be an article entirely indispensable in some lines of manufacture, retains its place in the commerce of the world.—*Indian Agriculturist.*

JARRAH WOOD IN CHURCH BUILDING.

The application of foreign woods in English church buildings is essentially an innovation of this latter part of the nineteenth century. In old English ecclesiastical buildings, we naturally look for the timber work, whether constructive or ornamental, to be formed of Oak. The wood seems specially adapted for the purpose, and from its association, to have become like the ancient churches themselves, almost hallowed in its use; but we are, apparently, about to change all this, and the latter half of this progressive century will be recorded in future history by the introduction of timber that will probably puzzle the archæologists of future ages. On the authority of *The Church Times*, we learn that in the recent, restorations of one of the most interesting of Kentish churches namely that of Herne, situated on the road between Canterbury and Herne Bay, and about 2 miles from the last-named watering place, the bays between the principal and intermediate rafters have been filled in with boarding and finished with mouldings, the spandrels being richly carved; the whole of the woodwork of the new roof being of Jarrah wood (Eucalyptus marginata) from Western Australia.—*Gardener's Chronicle.*

THE VAMPIRE VINE.

Every one has read Victor Hugo's description of the octopus, which has hitherto been regarded as the most hateful and horrible of all created things. According to *Lucifer*, however, there has been discovered in Nicaragua a plant which is as horrible as the devil fish. This is a vine called by the natives "the devil's snare," which seems literally to drain the blood of any living thing which comes within its death-dealing touch.

Mr. Dunstan, maturalist, who has recently returned from Central America, where he spent nearly two years in the study of the flora and the fauna of the country, relates the finding of a singular growth in one of the swamps which surround the great lakes of Nicaragua. He was engaged in hunting for botanical and entomological specimens, when he heard his dog cry out, as if in agony, from a distance. Running to the spot whence the animal's cries came, Mr. Dunstan found him enveloped in a perfect network of what seemed to be a fine rope-like tissue of roots and fibres. The plant or vine seemed composed entirely of bare interlacing stems, resembling, more than anything else, the branches of the weeping willow denuded of its foliage, but of a dark, nearly black hue, and covered with a thick viscid gum that exuded from the pores. Drawing his knife, Mr. Dunstan endeavoured to cut the animal free, but it was only with the greatest difficulty that he succeeded in severing the fleshy muscular fibres. To his horror and amazement the naturalist then saw that the dog's body was blood-stained, while the skin appeared to have been actually sucked or puckered in spots, and the animal staggered as if from exhaustion. In cutting the vine the twigs curled like living, sinuous fingers about Mr. Dunstan's hand, and it required no slight force to free the member from its clinging grasp, which left the flesh red and blistered. The gum exuding from the vine was of a greyish-dark tinge remarkably adhesive, and of a disagreeable animal odour, powerful and nauseating to inhale. The native servants who accompanied Mr. Dunstan manifested the greatest horror of the vine, which they call "the devil's snare," and were full of stories of its death-dealing powers. He was able to discover very little about the nature of the plant, owing to the difficulty of handling it, for its grasp can only be torn away with the loss of skin and even of flesh; but, as near as Mr. Dunstan could ascertain, its power of suction is contained in a number of infinitesimal mouths or little suckers, which, ordinarily closed, open for the reception of food. If the substance is animal, the blood is drawn off and the carcass or refuse then dropped. A lump of raw meat being thrown it, in the short space of five minutes the blood will be thoroughly drunk off and the mass thrown aside. Its voracity is almost beyond belief.

Supply of fuelwood in rural areas

In Arunachal Pradesh there are 2,978 villages in an area of 83,478 km^2 with about 28.0 km^2 of forested areas around each village on the average. The entire quantity of required fuelwood is collected from the adjoining forests by the villagers as a matter of traditional right and is unrecorded.

Need for energy plantations

Though the density of population in this Union Territory is low and there are adequate forested areas in and around the villages yet due to continuous and intensive extraction of the fuelwood, the areas near about the villages and growing townships are getting depleted very fast. Some places in the territory such as Wanchoo areas are very thickly populated and all the forested areas in and around the villages have been destroyed by intensive shifting cultivation. The fuelwood for every day use is now collected and transported on head load from a distance of 7 to 8 km.

Few decades ago the population versus area ratio in other parts of India had been identical and the energy available in and around the habitations in the form of fuel were apparently sufficient to meet the energy of the population. Thus, no planning was made in past for sustained supply of energy in the form of fuelwood with the result that the present situation has cropped up elsewhere in India. By hacking the forests in and around places the habitations the environmental equilibrium has been disturbed thoroughly and in many beyond any rectification.

Planting for energy

It is, therefore, necessary and essential that an organised programme for energy plantation be set up in Arunachal Pradesh so that the mistake that has been committed elsewhere is not repeated here. Till now considerable extent of areas have been brought under the plantations, though many of them have not been raised with the soleobject of supplying energy. Mostly the plantations have been created to produce timber. The lops and tops from these plantation will go a long way in fulfilling the daily demand for energy.

The erstwhile Norh East Frontier Agency (now Arunachal Pradesh) Forest Department was constituted in 1948 and since then the various works done by the forest department in the direction of afforestation and other plantations are as below:

(a)	Plantations of tree species as a measure of compensation for timber extraction.	11,717 ha
(b)	Raising of fuelwood plantations in the neighbourhood of towns and villages.	240 ha
(c)	Aided natural regeneration where the existing natural regeneration is being improved	8,480 ha
(d)	Afforestation of thatch areas etc. which were lying unproductive for years.	1,566 ha
(e)	Raising plantations of minor forest produce of economic value.	264 ha
	Total	22,267.0 ha

Table 2

The programme for plantations in Arunachal Pradesh during the period 1979–80 to 1982–83

Particulars	1979–80 (ha)	1980–81 (ha)	1981–82 (ha)	1982–83 (ha)	Total (ha)
Artificial Plantation	1570	3200	3200	3400	11370
Afforestation	75	85	85	85	330
Station Reserve around towns	30	35	35	40	140
Minor Forest Produce	158	900	1000	050	3108
Afforestation (Centrally sponsored)	200	400	1000	1000	2600
Aided Natural Regeneration	800	800	800	800	3200 ha.

The programme of plantations for Arunachal Pradesh for the period 1979–83 is presented in Table 2. A pilot plantation project of 12 km^2 is also being raised for the Mintung area. Avenue plantation of 600 row km is also expected to be completed by 1983.

Conclusion

At present considerable difficulties are being experienced for implementaion plantation schemes due to inadequacy of funds. It is hoped that with the adequate allotment of fund from the Planning Commission in the coming years, it will be possible to implement the schemes in a bigger way and mitigate the problem of energy in rural areas.

SUMMARY

Firewood is the chief of source of energy in Arunachal Pradesh. The entire quantity *of fuelwood is collected from the adjoining forests by the villagers as a matter of traditional* right. The use of gobar gas plant is uneconomical because of the lower temperatures prevailing in major portions of the year. The anticipated requirement of fuelwood for 1990 and 2000 is of the order of 5.88 and 8.23 million m^3, respectively. Though the present fuelwood requirements have not attained critical dimensions, the hacking of forests in and around the habitations is creating serious environmental problems. Programmes have been initiated for raising energy plantations in Arunachal Pradesh. An outline of the programmes underway and projects proposed are presented. The main problem in implementation are inadequacy of funds. The removal of this constraint will help in solving the anticipated energy crisis in this area at the same time affording sufficient environmental protection.

अरुणाचल प्रदेश में ऊर्जा रोपवन लगाना

लेखक जे० एम० चौधरी

सारांश

अरुणाचल प्रदेश में ईंधनकाष्ट ही ऊर्जा का मुख्य स्रोत है। ईंधनकाष्ठ की समूची मात्रा ग्रामीणों द्वारा पारम्परिक अधिकार के रूप में आस-पास के वनों से इकट्ठा की जाती है। गोबर गैस संयंत्र लगाना आर्थिक पास दृष्टि से लाभप्रद नहीं है, क्योंकि वर्ष में अधिक समय तक यहां तापमान बहुत निम्न रहता है। 1990 और